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AJO PEAK TO TINAJAS ALTAS: A FLORA OF SOUTHWESTERN ARIZONA PART 11. EUDICOTS: BRASSICACEAE AND BURSERACEAE

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ABSTRACT

A floristic account is provided for the mustard and frankincense families as part of the vascular plant flora of the contiguous protected areas of Organ Pipe Cactus National Monument, Cabeza Prieta National Wildlife Refuge, and the Tinajas Altas Region in the Sonoran Desert of southwestern Arizona. The mustard family in the flora area includes 23 genera and 32 species; the majority are cool-season annuals (ephemerals). There are no hot-season annuals. *Lyrocarpa coulteri* and *Hesperidanthus* are the only mustards in the flora area growing during the warmer seasons. Among the 12 non-native species only 3 are established as reproducing populations in the flora area. Five species are represented in the fossil record. *Sibara angelorum* in Cabeza Prieta NWR is the only record for the United States. The frankincense family includes a single species (*Bursera microphylla*) in the flora area as well as in southwestern USA. This is the eleventh contribution for this flora published in Phytoneuron and also posted open-access on the website of the University of Arizona Herbarium (ARIZ).

This contribution to the vascular plant flora in southwestern Arizona is the eleventh published in a series in Phytoneuron and also posted open-access on the website of the University of Arizona Herbarium (ARIZ). The area of coverage is that of the contiguous protected areas of Organ Pipe Cactus National Monument, Cabeza Prieta NWR, and the Tinajas Altas Region in the heart of the Sonoran Desert (Figure 1). Two eudicot families are included in this contribution: Brassicaceae and Burseraceae.

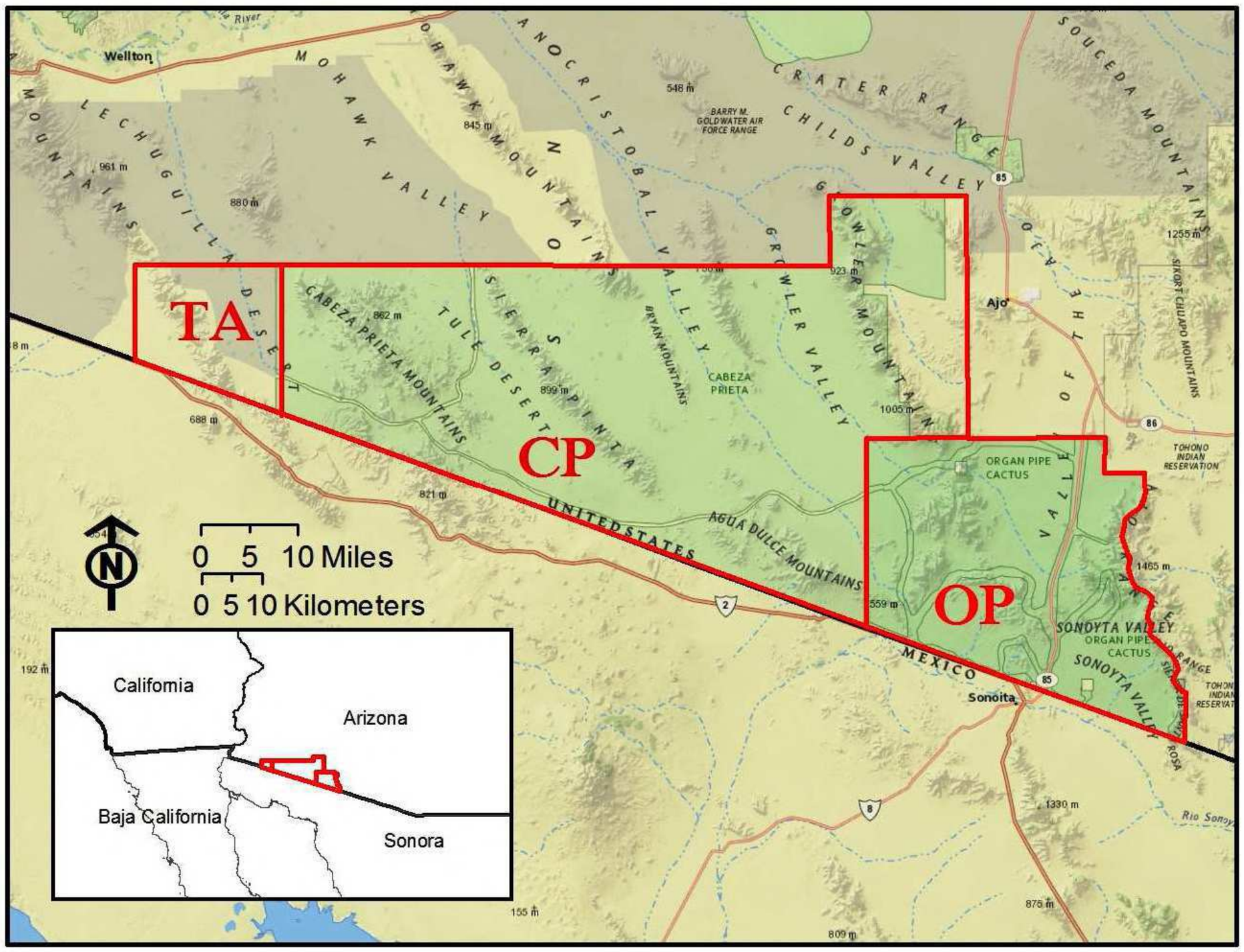

Figure 1. Flora area in southwestern Arizona. TA = Tinajas Altas. CP = Cabeza Prieta NWR. OP = Organ Pipe Cactus NM. Green shading indicates approximate boundaries of federally designated wilderness.

The first article in this series includes maps and brief descriptions of the physical, biological, ecological, floristic, and deep history of the flora area (Felger et al. 2013a). This flora includes the modern, present-day taxa as well as fossil records from packrat middens.

Fossil specimens are indicated with a dagger symbol (†) and the one fossil taxon no longer present in the flora area (*Athysanus pusillus*) is marked with two dagger symbols (††). Non-native species are marked with an asterisk (*) and non-natives not established (not reproducing) in the flora area are marked with double asterisks (**). In the following species accounts, the accepted scientific names are in bold and selected synonyms are italicized within brackets [--]. Common names, when known or worthwhile, are in English, Spanish, and the Hia-Ced O'odham dialect, respectively (see Felger 2007 and Felger et al. 1992 for usage of Hia-Ced O'odham plant names). Spanish-language names are italicized. The qualifications *about* and *approximately* are generally omitted, with the obvious understanding that such quantitative values are, to varying degrees, seldom exact. The identification keys are for the modern flora.

All photos and scans are by Sue Rutman unless otherwise stated. All specimens cited are at the University of Arizona Herbarium (ARIZ) unless otherwise indicated by the abbreviations for herbaria at Cabeza Prieta National Wildlife Refuge (CAB), Organ Pipe Cactus National Monument (ORPI), and the standardized abbreviations for herbaria (Index Herbariorum, Thiers 2013). We have seen specimens or images of all specimens cited. When no collection number is provided, the

specimen is identified by the date of collection. Generally only the first collector's name is given. Area designations are: OP = Organ Pipe Cactus National Monument, CP = Cabeza Prieta National Wildlife Refuge, and TA = Tinajas Altas Region. Additional explanation of the format for this flora series is provided in part 3 (Felger et al. 2013b). Descriptions and keys pertain to taxa and populations as they occur in the flora area.

BRASSICACEAE (CRUCIFERAE) – Mustard Family

Annual (ephemeral) and perennial herbs; containing mustard oils. Leaves alternate, the lower leaves often in a basal rosette; without stipules. Sepals and petals in a cross-like pattern—hence the alternate family name Cruciferae. Calyx cylindrical with 4 separate, mostly deciduous sepals. Petals 4 (or fewer or rarely absent), separate, mostly clawed (conspicuously narrowed basally). Stamens 6 (or sometimes fewer), usually with 2 outer, shorter stamens, and 4 inner ones of 2 opposite pairs. Ovary superior. Fruits (siliques or silicles) highly variable, dry, mostly 2-chambered capsules, dehiscent by 2 valves opening from base to apex, or sometimes 1-chambered and indehiscent, or separating into 1-seeded segments. Seeds often mucilaginous when wet. The family is easily recognized but the genera are often distinguished on technical characters of the fruit that can be difficult for the non-specialist to differentiate.

Crucifers recorded from the general flora area include 23 genera with 32 species (Table 1). Among the 32 species, 28 are cool-season ephemerals including 9 species not established as reproducing populations; non-natives include 12 species, and 9 of them are not established as reproducing populations in the flora area. Five or six species have been found in fossil packrat middens, one of which, *Athysanus pusillus*, is no longer present in the flora area.

Table 1. Local distributions of Brassicaceae and Burseraceae taxa. † = Taxa represented by a fossil specimen(s); †† = fossil taxon no longer present in the flora area; * = non-native taxa; ** = non-native taxa not established in the flora area. OP = Organ Pipe Cactus National Monument; CP = Cabeza Prieta National Wildlife Refuge; TA = Tinajas Altas Region. SU = summer/warm-season ephemerals; WI = cool-season/winter-spring ephemerals; PR = perennials. Localities and growth forms in parentheses are ones that are rare or seldom found and apparently not reproducing, or known only from fossils, and not part of the modern flora; these are not counted in the totals.

Taxon	**Region**			**Growth Form**		
	Organ Pipe	Cabeza Prieta	Tinajas Altas	Ephemerals		Perennials
				Summer	Winter	
BRASSICACEAE						
††*Athysanus pusillus*	(OP)				(WI)	
Boechera perennans	OP					PR
****Brassica kaber*	(OP)				(WI)	
****Brassica nigra*	(OP)				(WI)	
***Brassica tournefortii*	OP	CP	TA		WI	
****Capsella bursa-pastoris*		(CP)			(WI)	
†*Descurainia pinnata*	OP	CP	TA		WI	
****Descurainia sophia*	(OP)				(WI)	
Dimorphocarpa pinnatifida		CP	(TA)		WI	
Dithyrea californica		CP	TA		WI	
***Eruca vesicaria*	OP				WI	
Erysimum capitatum	OP				WI	
Hesperidanthus linearifolius	OP					PR
†*Lepidium lasiocarpum*	OP	CP	TA		WI	
Lepidium oblongum	OP				WI	
Lepidium thurberi	OP				WI	

†*Lepidium* sp./spp.	(OP)		(TA)		(WI)	
Lyrocarpa coulteri	OP	CP	TA			PR
******Matthiola longipetala*	(OP)				(WI)	
******Nasturtium officinale*	(OP)					(PR)
Physaria tenella	OP	CP	TA		WI	
Planodes virginicum		CP			WI	
Sibara angelorum		CP			WI	
******Sisymbrium altissimum*	(OP)				(WI)	
**Sisymbrium irio*	OP	CP			WI	
******Sisymbrium orientale*	(OP)	(CP)			(WI)	
Streptanthus carinatus	OP				WI	
Streptanthus lasiophyllus	OP	CP	TA		WI	
Streptanthus longirostris		CP			WI	
Thelypodium wrightii	OP				WI	
******Thlaspi arvense*	(OP)				(WI)	
†*Thysanocarpus curvipes*	OP	CP	(†TA)		WI	
†*Tomostima cuneifolia*	OP	CP	TA		WI	
TOTALS	17	14	8	0	19	3
BURSERACEAE						
†Bursera microphylla	OP	CP	TA			PR

Most Sonoran Desert mustards are winter-spring ephemerals and produce their first and usually largest leaves in a basal rosette; cauline leaves (stem leaves above the basal rosette) are often gradually reduced above. *Lyrocarpa* is the exception, being perennial without a basal rosette and flowering at any time of year with sufficient moisture. A few herbaceous perennials such as *Boechera* and *Hesperidanthus* extend only to the margins of the desert, but like most Sonoran Desert crucifers, they grow and flower during the cooler seasons. *Hesperidanthus* also flowers after summer rains in August and September. (*Stanleya pinnata* in the Kofa Mountains, north of the flora area, is one of the few other perennial members of the mustard family that extend into the Sonoran Desert. It is, however, summer-dormant in the desert and only reaches the margin of the desert.) *Lepidium thurberi* is often biennial, but where it ranges into the desert it is an ephemeral.

The young plants of more than a dozen local species are potentially edible as greens, and the seeds are likewise potentially edible (Felger 2007; Hodgson 2001; Uphof 1968). The most economically important crucifers are in the genus *Brassica*; others include horseradish, radish, watercress, and ornamental garden flowers such as stock and wallflower. The family is worldwide with 321 genera and 3660 species (Al-Shehbaz 2010, 2012).

1. Fruits less than 2 (3) times longer than wide, variously shaped.

    2. Plants with stellate hairs; petals yellow; fruits globose, bladder-like..... **Physaria**
    2. Plants with dendritic (branched) or simple hairs; petals white, or brownish to dull purple; fruits variously shaped, compressed (flattened).

        3. Fruits spectacle-shaped (of 2 disc-shaped halves) joined by about 25% of their margins; flowers very fragrant; dunes and sand soils.

            4. Leaves with slender lobes; petals (fresh) 5–7 mm long; fruiting pedicels 7–22 mm long; stigma triangular..... **Dimorphocarpa**
            4. Leaves with broad, coarse teeth or lobes; petals (fresh) 10–12 mm long; fruiting pedicels 1.5–2.5 mm long; stigma rounded..... **Dithyrea**

3. Fruits not of 2 disc-shaped halves; flowers fragrant or not.

5. Perennials (sometimes flowering in first season), with dendritic hairs; petals 12–20+ mm long; fruits 10–28 mm long..... **Lyrocarpa**
5. Winter-spring ephemerals, glabrous or with simple hairs; petals to 3 mm long or absent; fruits to 7.5 mm long.

6. Pedicels somewhat thick, straight to slightly curved; fruits 3–4 mm long, 2–seeded, not winged or inconspicuously winged at apex..... **Lepidium**
6. Pedicels slender, recurved; fruits 5.5–7.5 mm long, 1–seeded, the margin conspicuously winged and often with small perforations (holes)..... **Thysanocarpus**

1. Fruits more than 3 times longer than wide, linear or narrowly oblong.

7. Plants glabrous or with simple hairs.

8. Fruit flattened; seeds winged or not.

9. Leaves pectinate, the segments linear; petals pale lavender to purplish; seeds wingless. .....**Sibara**
9. Leaves entire to dentate, pinnatifid or pinnatisect; petals purple, white (sometimes tinged maroon or with purple veins); seeds winged.

10. Stem (cauline) leaves clasping; petals 14–18 mm long; fruits 4–6 mm wide..... **Streptanthus carinatus**
10. Stem leaves not clasping—sessile or petiolate; petals less than 10 mm long; fruits less than 2 mm wide.

11. Leaves pinnatifid to pinnatisect; petals whitish; fruit 1–1.5 mm wide, not beaked..... **Planodes**
11. Leaves entire, dentate to sinuate, or pinnatifid; petals white (sometimes tinged with maroon or with purple veins) or purple; fruit 4–6 mm wide or with an indehiscent beak-like tip 3–5 mm long..... **Streptanthus** (in part)

8. Fruit rounded in cross-section (terete); seeds not winged.

12. Fruits with a tapering beak usually 2 mm or more long..... **Brassica**
12. Fruits not beaked.

13. Fruits often turned downward at maturity or spreading to ascending; fruiting pedicels 0.5–3 mm long..... **Streptanthus lasiophyllus**
13. Fruits ascending or spreading; fruiting pedicels 4–20 mm long.

14. Petals yellowish; cauline leaves pinnately lobed or pinnatisect; widespread. ..... **Sisymbrium**
14. Petals white to purplish; cauline leaves entire or pinnately lobed; Ajo and Diablo Mts.

15. Outer pair of sepals with a callus (thickening) near the tip of each sepal; petals purple to pinkish or rarely white; stigmas 2-lobed; fruits not constricted between the seeds..... **Hesperidanthus**

5. Outer pair of sepals without a callus; petals white or rarely purplish; stigmas entire; fruits constricted between seeds.....**Thelypodium**

7. Plants with branched hairs (T-shaped, Y-shaped, or dendritic).

16. Plants with T-shaped (2-armed) hairs; Ajo Mts..... **Erysimum**
16. Plants with dendritic hairs.

17. Leaves finely divided; petals yellow to pale yellow..... **Descurainia**
17. Leaves entire to toothed (dentate); petals white or pink to purple.

18. Ephemerals; leaves all basal, l; fruits to 1.2 cm long; widespread..... **Tomostima**
18. Ephemerals and perennials; leaves not all basal; fruits 4 or more cm long; in the Ajo Mts or rare.

19. Perennials; petals 5–9 mm long; fruits 4–7 cm long; Ajo Mts..... **Boechera**
19. Annuals; petals 15 or more mm long; fruits 5–7 cm long; lowlands, scarce and probably not established..... **Matthiola**

Athysanus

Two species in western North America including northwestern Mexico.

††**Athysanus pusillus** (Hooker) Greene
[*Thysanocarpus pusillus* Hooker]
Common sandweed

Slender and delicate, cool-season ephemerals. Flowers rather inconspicuous with small white petals or often without petals. Fruits flat, rounded in outline, and 1-seeded.

It was in the Ajo Mountains more than 13,500 years ago. The nearest present-day populations are in the Kofa Mountains and near Tucson. In Arizona mostly at elevations above the desert. Western North America from British Columbia to Baja California and central Arizona.

OP: †Montezuma's Head, fruits, 13,500 ybp.

Boechera

Mostly perennial herbs; 110 species in North America including northern Mexico, and Russian Far East.

Boechera perennans (S. Watson) W.A. Weber
[*Arabis perennans* S. Watson]
Rockcress. Figure 2.

Perennial herbs, to 70 cm tall from a woody caudex. Stems usually 2–5 per caudex branch, densely pubescent proximally with Y-shaped and often 3–5-branched (dendritic) or rarely simple hairs, usually glabrous distally. Basal leaves oblanceolate to obovate, the margins dentate, the blade surfaces densely pubescent with 3–6-branched hairs. Cauline leaves clasping the stem, the uppermost usually glabrous. Fruiting pedicels usually horizontal, 6–25 mm long. Petals whitish tinged with pink or purple, 5–9 mm long. Fruits widely pendent and usually curved, (3) 4–7 cm × 1.7–2.1 mm, glabrous; ovules 60–96 per ovary. Growing and flowering during the cooler seasons of the year.

Ajo Mountains, often among rocks, especially canyons and slopes at higher elevations. It does not extend into the lower desert.

Southwestern United States and northern Mexico in Baja California, Chihuahua, and northern Sonora.

OP: Alamo Canyon: 2500 ft, *Nichol 14 Mar 1939*. Canyon bottom at margin of wash, 29 Mar 2003, *Felger 03-421*. Arch Canyon trail, corolla blue-purple, 11 Mar 1983, *Daniel 2617* (ASU). Middle fork Alamo Canyon near crestline of Ajo Mts, 15 Mar 2003, *Rutman 2003-340* (ORPI).

Sonora: Banori, Altar Dist., 15 Feb 1938, *Gentry 3540*.

Figure 2. *Boechera perennans*. (A) Arch Canyon, 29 Feb 2009. (B) Woods Canyon, S of Sedona, Yavapai Co., 26 Feb 2005, photo by Max Licher (SEINet).

***Brassica** – Mustard; *mostaza*

Cool-season ephemerals with yellow flowers and slender, dehiscent fruits (those in the flora area). Molecular phylogenetic studies have revealed that the genus *Brassica* is not monophyletic and the generic boundary will need revising (Warwick & Sauder 2005).

Native to the Old World (*B. kaber* may be an exception), widely cultivated and introduced worldwide; includes cabbage, canola, cole, mustard, and turnip; 43 species.

1. Flowers pale yellow, the petals 6–8 mm long; fruits 3.5–7 cm long, widely spreading, the beak 10–20 mm long..... **Brassica tournefortii**
1. Flowers bright yellow, the petals usually 8 or more mm long; fruits less than 2.5 cm long, erect and appressed to the flowering stem (rachis), the beak 1–6 mm long.

2. Outer pair of sepals with a callus (thickening) near the tip; fruit valves each with 3–7 veins, the lateral veins conspicuous (need mature fruits)..... **Brassica kaber**
2. Outer pair of sepals without a callus; fruit valves each with 1 prominent midvein, the lateral veins inconspicuous..... **Brassica nigra**

****Brassica kaber** (de Candolle) L.C. Wheeler
[*Sinapis arvensis* Linnaeus; *S. kaber* de Candolle. Not *Brassica arvensis* Linnaeus; *B. arvensis* Rabenhorst is illegitimate]
Charlock. Figure 3.

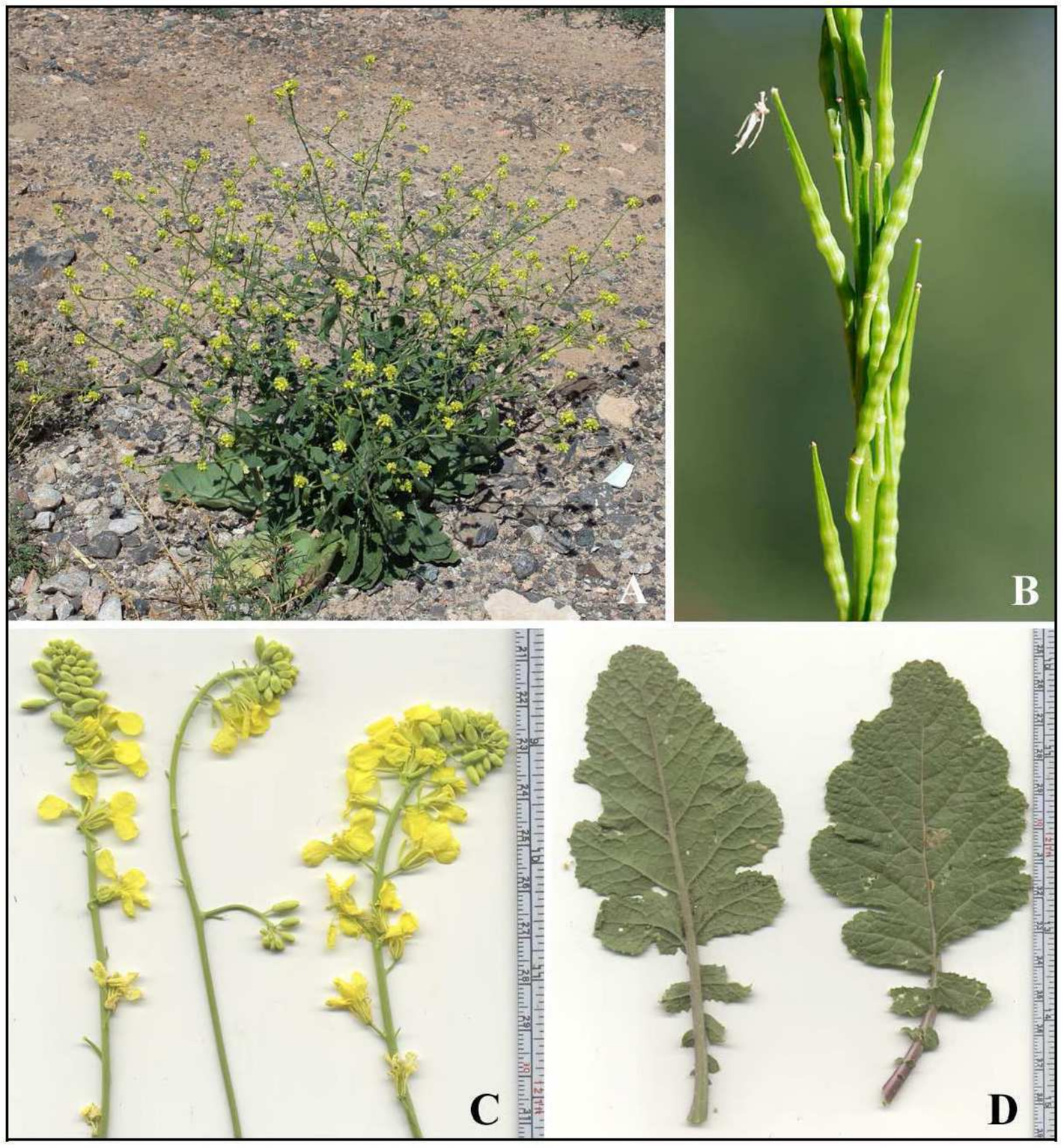

Figure 3. *Brassica kaber*. (A, C & D) Mex Hwy 2 at Los Vidrios, Sonora, 5 Mar 2014. (B) Merced River, Briceburg, Mariposa Co., CA, 21 Mar 2009, photo © by Barry Breckling (CalPhotos).

Cool-season ephemerals, 0.5–1.5+ m tall, the lower part of the plant often with coarse hairs (hispid). Basal leaves obovate, oblong, or lanceolate, (8.5) 25–50+ cm long, (3.5) 15–27 cm wide, and lyrate, pinnatifid or sometimes undivided; upper (cauline) leaves with coarsely toothed margins and often simple. Sepals, petals, stamens, and young ovary yellow, the petals uniformly bright yellow, 8–12 (17) mm long, the blade broadly obovate, the claw slender. Fruiting pedicels ascending, 3–7 mm long. Fruits linear, terete, 1.5–5.7 cm × 1.5–4.3 mm; ovules (4) 8–16 (24) per ovary.

Common farm weed and sometimes along roadsides near the flora area in southern Arizona and northwestern Sonora; not known from the flora area but occasional plants might be expected

along Highway 85. Native to the Mediterranean region, and non-native, weedy, and widespread in North America and elsewhere in the world. Also reported to be in the northeastern United States 8000 years ago, suggesting it originally had a semi-circumboreal distribution (Jacobson et al. 1988; Warwick 2010). *Brassica kaber* is easily confused with *B. nigra* and they are difficult to tell apart without mature fruits, or sometimes even with mature fruits.

Maricopa Co: 10–15 mi W of Gila Bend on I-8 and 0.8 mi E of Paloma Rd, roadside by agricultural fields, locally abundant weed to about 4 ft. high, 3 Mar 2001, *Salywon 980* (ASU).

Pinal Co: Junction of I-8 and Bianco Rd, ca. 5 mi SW of Casa Grande, roadside, 100% cover of *Brassica, Erodium cicutarium*, and other weedy ephemerals, 25 Feb 1993, *Felger 93-28* (ARIZ, ASU).

Yuma Co: Yuma mesa, *Vince Roth 30 June 1957* (det. *B. tournefortii* by C.T. Mason 1985; det. *S. arvensis* by Suzanne I. Warwick 1995).

****Brassica nigra*** (Linnaeus) W.D.J. Koch
[*Sinapis nigra* Linnaeus]
Black mustard; *mostaza negra*. Figure 4.

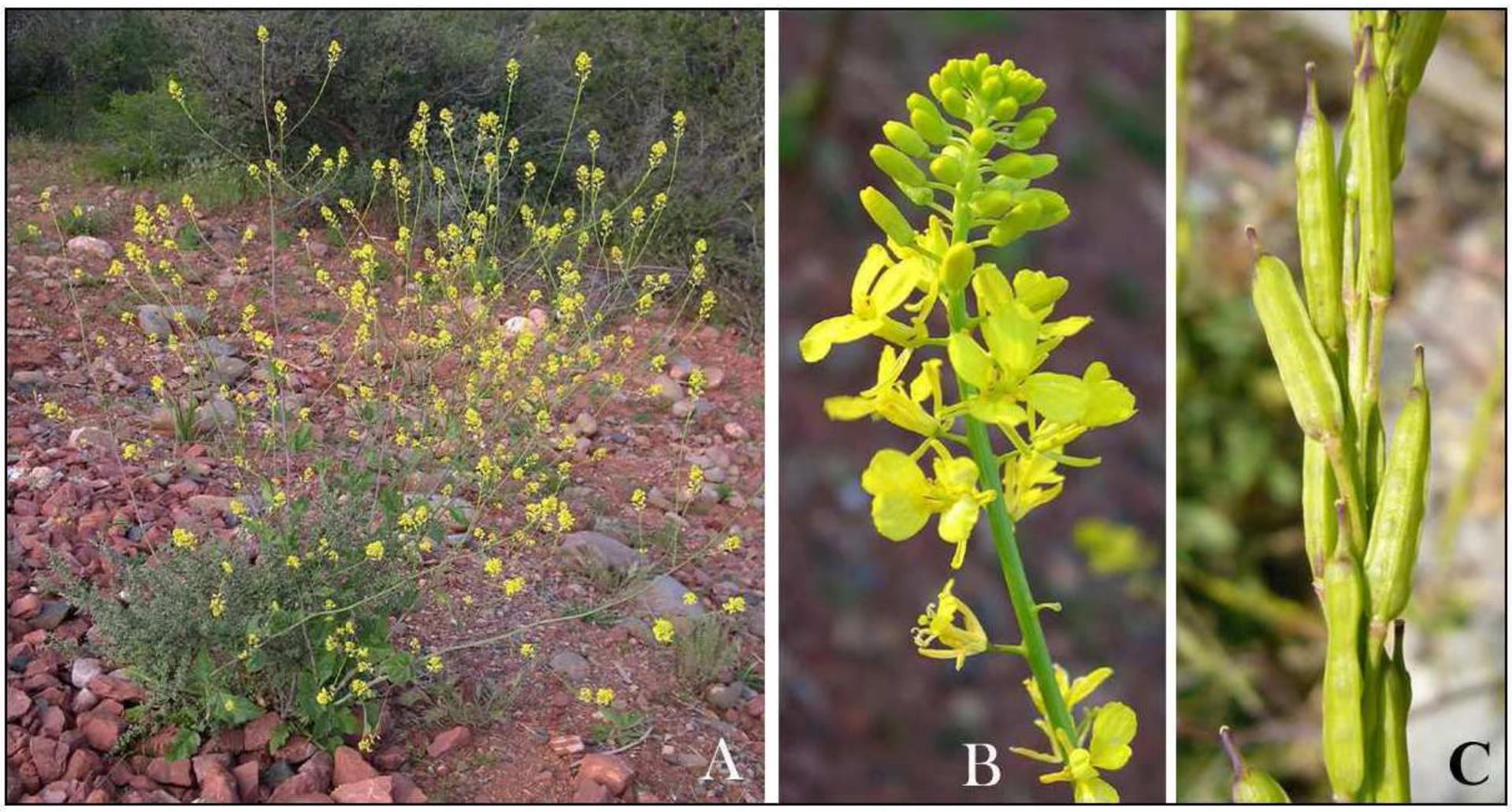

Figure 4. *Brassica nigra*. (A & B) Sedona, Yavapai Co., 2 May 2005, photos by Max Licher (SEINet). (C) Hercules, Contra Costa Co., CA, Jun 2009, photo © by Zoya Akulova (CalPhotos).

Plants sparsely pubescent with soft hairs or glabrate; reaching 50–100 cm tall, with spreading flowering branches. Basal rosette leaves 8–30 (50) cm long, the stem leaves reduced upwards; leaves variable, similar to those of *B. tournefortii* but usually greener and with broader lobes. Flowers bright yellow and showy. Sepals 10 mm long. Petals clawed, 15–24 × 7+ mm, the veins inconspicuous on fresh flowers, dark and conspicuous when dried. Fruiting racemes often 20–40 cm long. Fruits erect and appressed, 20–22 mm long, more or less 4-angled, the beak seedless, about ¾ as long as the body; fruiting pedicels 3–4.5+ mm long. Seeds globose, ca. 2 mm in diameter, not mucilaginous when wet.

Occasional in disturbed habitats including roadsides and parking lots; not established in the flora area. Usually blooming in April after most native ephemerals.

A worldwide weed, native to Eurasia, and also cultivated as a mustard condiment. Present in Arizona at least since 1884.

OP: Alamo Wash-Sonoyta road, 22 Apr 1941, *Supernaugh 6* (ORPI). Hwy 85, 2.5 mi S of Eagle Pass, 7 Apr 2003, *Rutman 2003-449*.

***Brassica tournefortii** Gouan
[*B. tournefortii* var. *dasycarpa* O.E. Schulz; *B. t.ournefortii* forma *dentata* O.E. Schulz; *B. tournefortii* var. *leiocarpa* Marie & Weiller; *B. tournefortii* var. *recurvata* Bornmüller; *B. tournefortii* var. *sisymbrioides* Fischer ex de Candolle]
Sahara mustard; *mostaza*. Figure 5.

Coarse ephemerals, with a well-developed taproot, highly variable in size, the plants as small as 15 cm tall when drought stressed, or sometimes reaching 1.2 m tall on dunes; stems simple to many-branched above. Lower part of plant densely hirsute with coarse, rough, white hairs, especially the lower leaf surfaces along the midrib, veins, and margins; glabrescent distally. When dry and dead these large plants break off at the root and may become tumbleweeds. Leaves of basal rosettes (8) 15–30 (80+) cm long, petioled, pinnatifid with the terminal lobe usually largest (lyrate-pinnatifid), or leaves of stunted plants often obovate and merely toothed; cauline (stem) leaves usually greatly reduced upwards.

Flowers selfing (autogamous). Sepals 3.5–4 mm long, pale, almost translucent, purple-brown, slightly swollen basally. Petals, stamens, and stigma pale yellow, often becoming whitish with age. Petals 4–8 mm long; corolla bilaterally symmetrical (unlike most other mustards, the petals are not at right angles to one another: two of the opposite angles are less than 90° and two are much more than 90°). Stamens at the same height as, and touching, the stigma (this contact between the stamens and the stigma occurs during flowering, indicating a self-pollinating reproductive strategy; e.g. Hinata et al. 1974 and Van Devender et al. 1997). Fruiting pedicels (6) 12–16 (22) mm, spreading to ascending. Fruits cylindric and torulose, 3–7 × 2–4 (5) cm, with a stout beak 11–20 mm long and 1 (2)-seeded. Seeds 1.3 mm in diameter, rounded, reddish brown, mucilaginous when wet. Seeds often germinate with fall rains, before the seeds of most native desert annuals germinate. When fully dry, the siliques can pop open with the touch of finger, and presumably when rattled by the wind. Many, however, just sit there on the plant, and need to roll around in the sand to open.

Widespread invasive weed in lowland disturbed and natural desert habitats across the flora area, especially on sandy soils and washes, but also on rocky slopes (Felger 1990). During favorable years it makes up a significant part of the plant cover on the dunes and sand hummocks of the Pinta Sands. The broad, spreading basal rosette leaves can effectively prevent the establishment of other cool-season ephemerals. Plants on sandy soils with sufficient soil moisture may grow to more than 1–1.5 meters across, making this species the largest herbaceous rosette plant in the region (Felger 2000: 186). Autogamy, together with the plasticity in plant size and early germination, undoubtedly contribute to the success of Sahara mustard in the Sonoran Desert and elsewhere.

On 28 March 2010, Richard Laugharn and Felger were in the miniature mesquite thicket in the Lechuguilla Valley where the Camino del Diablo crosses Coyote Wash and Felger made the following observations: "Much of the ground is now 100% covered by *Brassica tournefortii* of incredible size variation, but each local niche or micro-habitat of *Brassica* generally has plants of the same size—some very crowded stands consist of dwarfed plants, some reproducing with only a single fruit of 3–7 seeds, the lower stem leaves 1–several cm long, and basal rosette leaves often only 1–3 or sometimes not developing, the stems extremely slender and the plants 8.7–11.4 and more cm in height. Other, less crowded, robust plants have rosette leaves more than 30 cm long. Obviously

B. tournefortii is changing the cool-season species diversity in this habitat. The soil is still damp from the last rains and where the ground is not covered by ephemerals there is a continuous blackish surface of biological soil crust that includes cyanobacteria."

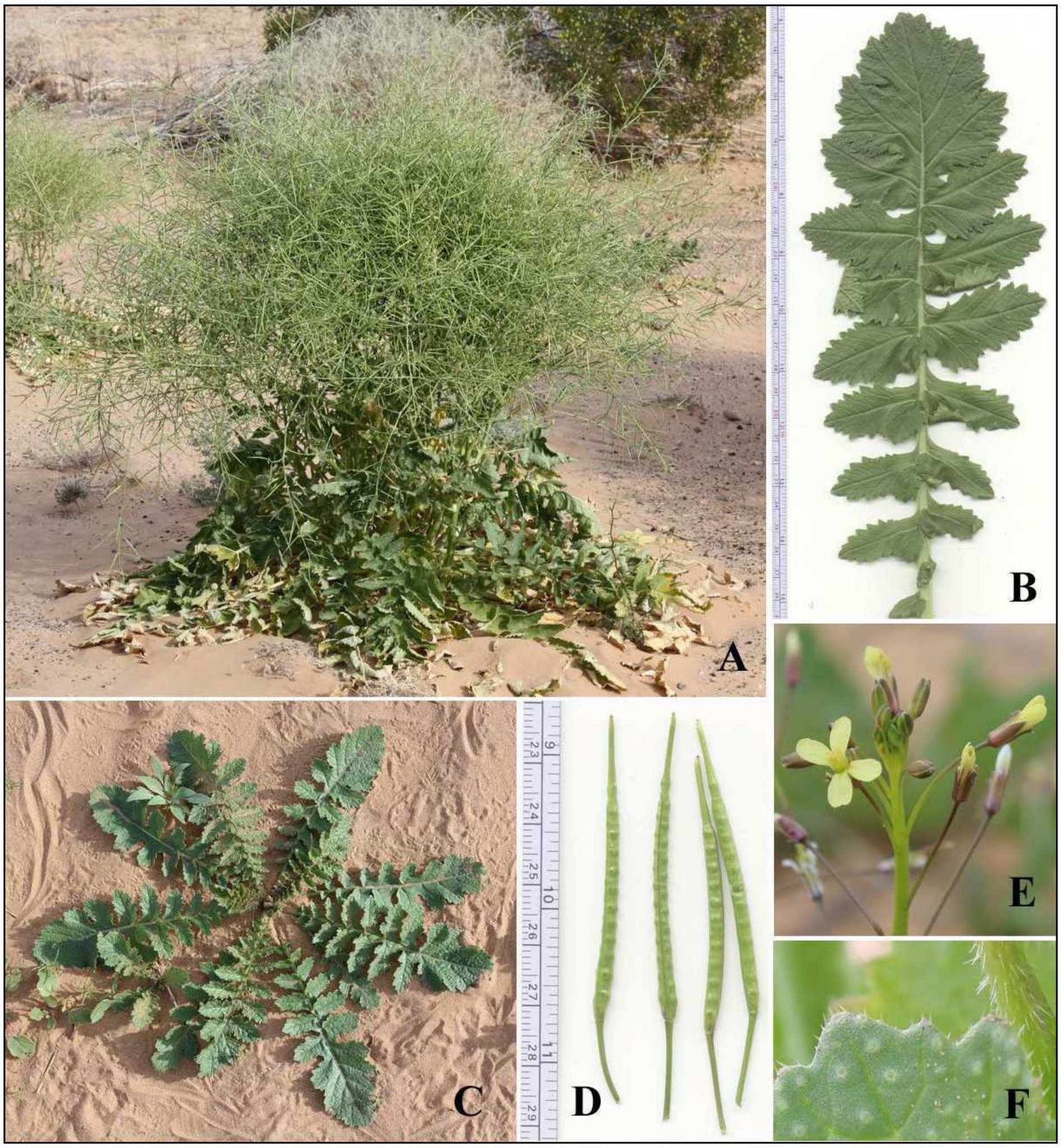

Figure 5. *Brassica tournefortii*. Dunes, 22 mi SW of Sonoyta on Mex Hwy 8, Sonora: (A) 3 Mar 2008; (C, E & F) 6 Feb 2014. (B & D) Alamo Wash, 29 Jan 2014.

Native to the Old World, probably North Africa and Central Asia, this species has become established in many warm, arid regions of the world. It has spread almost explosively across the Sonoran Desert, especially in sandy soil habitats. Sahara mustard is one of the most seriously invasive species in the flora region (Guertin 2003 provides an excellent summary of related information). Sahara mustard has also spread to Nevada, Utah, New Mexico, Texas, and northern

Mexico, as well other parts of the world such as Australia where it has become invasive. It was first reported from southeastern California by Jepson (1923–1924), apparently first collected in North America at Coachella in Riverside County in 1927, and established in agricultural areas in southeastern California by 1938. The earliest Arizona specimen is from 1955; Sahara mustard was collected in northwestern Sonora in 1966; and since at least the 1970s it has become widespread in the Sonoran Desert Region (Barrows et al. 2009; Dimmitt & Van Devender 2009; Felger 1990, 2000; Malusa et al. 2003; Van Devender et al. 1997).

Ihsan Al-Shehbaz (pers. com., 17 Dec 2014) wrote, "I do not divide *B. tournefortii* into infraspecific taxa based on density of indumentum, and I personally do not see sharp discontinuous differences in flower size." However, there are reports of infraspecific variation. For example, Zohary (1966: 309) reported that in the Middle East, "desert specimens are more densely hispid and have smaller flowers; they are probably to be classed as a separate subspecies." René Maire (1965) included 5 varieties and one forma in the Flora of North Africa, although currently considered as synonyms (e.g., Warwick 2010). Mark Dimmitt (pers. com. 2014) reported, "The original introduction of *B. tournefortii* near Mecca, California, is still present, and looks and behaves differently from other populations. It is a smaller, more gracile plant found only in disturbed soils where it is competing with numerous other exotic weeds. I did not see it in undisturbed desert in the Coachella Valley. The really invasive form is a later introduction with more aggressive traits." The USDA North Central Regional Plant Introduction Station in Ames, Iowa, has several accessions of this species for distribution as an experimental oilseed. However, Marushia (2009) found no differences between mesic and desert populations of *B. tournefortii*, but noted that the species has a more rapid phenology than its congeners (Marushia et al. 2010). Li and Malusa (2014) found that it has a germination rate (mean > 80%) in the field significantly higher than the native cool season annuals.

Minnich and Sanders (2000) report nearly 100% fruit set on most plants and that rain facilitates the production of a sticky gel (seeds become mucilaginous when wet) covering the seed capsule, permitting long distance dispersal of the seeds by adhesion to animals, and possibly vehicles. In Organ Pipe Cactus National Monument, Sue Rutman has observed entire cohorts of seedlings killed by freezing temperatures (also see Dhawan et al. 1982). However, the annual frequency of freezing temperatures in Organ Pipe (and elsewhere in the Sonoran Desert) has been decreasing since the 1980s (Weiss & Overpeck 2005), perhaps even further facilitating the success of Sahara mustard.

OP: Quitobaquito: 8 Feb 1978, *Bowers 1030*; 29 Mar 1988, *Felger 88-136*. Visitor Center, roadside, 16 Feb 1979, *Bowers 1566*. Cipriano Hills, 20 Mar 2003, *Rutman 2003-365* (ORPI).

CP: Charlie Bell Pass, 3 Apr 1992, *Whipple 3952*. Papago Well, 26 Feb 1993, *Felger 93-418*. Pinta Sands, 11 Apr 1993, *Felger 93-418*.

TA: Tinajas Altas Mts, above the tinajas, 19 Mar 1998, *Felger* (observation). Camino del Diablo, E of Raven Butte, 29 Nov 2001, *Felger* (observation). Coyote Water, 25 Oct 2004, *Felger 04-33*. Camino del Diablo at Coyote Wash, 28 Mar 2010, *Felger 10-172*. Surveyors Canyon, Lamb Tank, 29 Mar 2010, *Felger 10-197*. Canyon below Raven Butte Tank, 29 Mar 2010, *Felger 10-242*.

Yuma Co.: Near Palm Canyon, Kofa Mountains, 2400 ft, 21 April 1955, *Haskell 5058 & C.F. Deaver* (ASC 10855; det. Reed C. Rollins). Yuma Mesa, 1 mi E of Airbase, *Hamilton 26 March 1959* (ARIZ 130879; det. Andrew C. Sanders 2000).

California: Riverside Co.: Coachella, *J.B. Feudge 25 Feb 1927* (RSA 1660; det. Andrew C. Sanders).

***Capsella**

Native to Eurasia; 5 species.

****Capsella bursa-pastoris** (Linnaeus) Medikus
Shepherd's purse; *hierba del pastor*. Figure 6.

Cool-season ephemerals, to 50 cm tall, sparsely to densely pubescent with 3–5-rayed hairs. Flowers minute, white. Fruits obcordate, strongly compressed (flattened), 0.3–1 cm × 2–9 mm.

About one dozen plants sprang up from discarded hay at a temporary horse pen in the southwest corner of Cabeza Prieta but did not become established. The nearest record is in the Yuma region and it is a potential weed in gardens and agricultural fields.

Native to Eurasia and now a worldwide weed.

CP: Bajada of Tordillo Butte, 27 Feb 1993, *Felger 93-201*.
Yuma Co.: In soil accumulated before first Gray Tank in west branch, Township 2S, Range 19E, Section 34, 1760 ft, rare at wet tanks, *8 Dec 1985 Russo 246*.

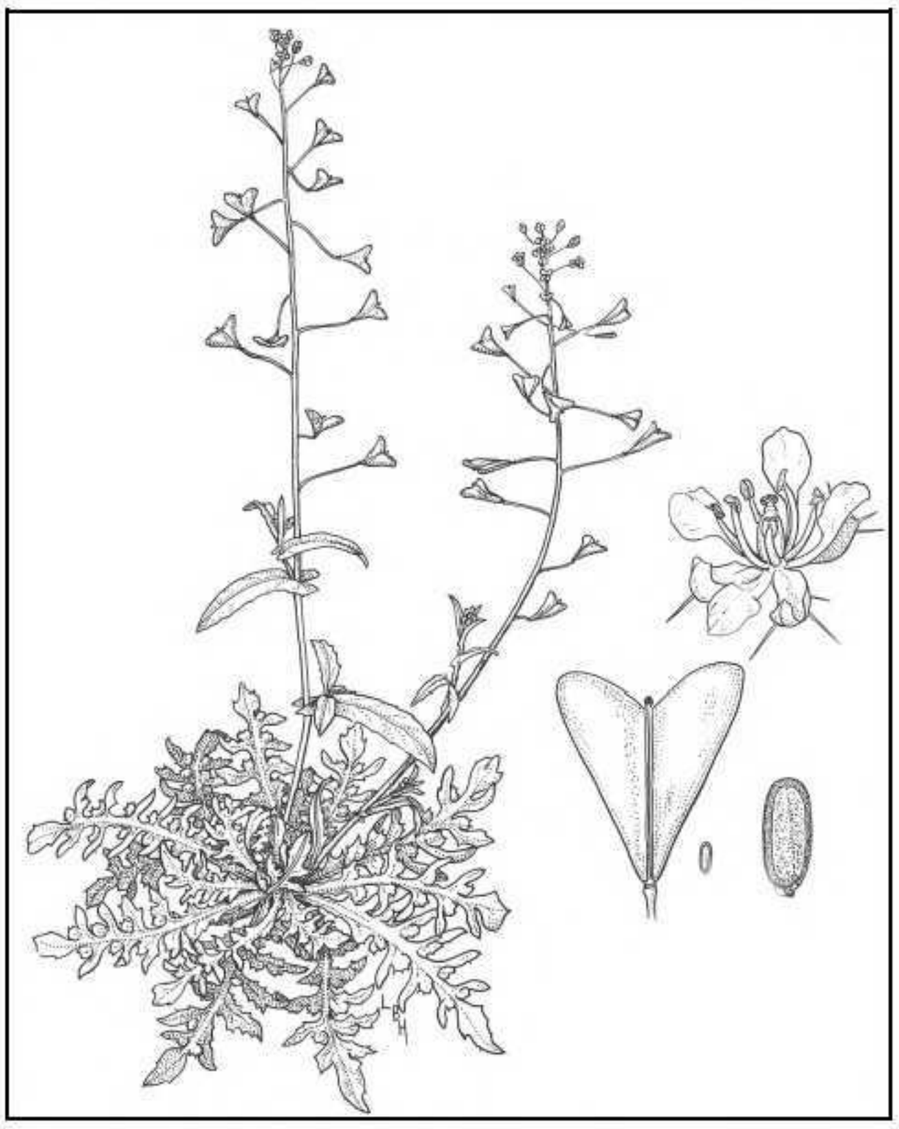

Figure 6. *Capsella bursa-pastoris*. By Lucretia Breazeale Hamilton.

Caulanthus, see **Streptanthus**

Descurainia – Tansy mustard
Americas, Eurasia, North Africa, and Canary Islands; 35 species.

1. Flowers pale yellow; fruits 3.5–7.2 mm long..... **Descurainia pinnata**
1. Flowers yellow; fruits 12–30 mm long..... **Descurainia sophia**

Descurainia pinnata (Walter) Britton
Western tansy mustard; *pamita*; su'uvad. Figure 7.

Cool-season ephemerals, 8–60 cm tall, mostly unbranched to few-branched above, with branched and candelabra-shaped, soft, white hairs. Stems leafy; early leaves usually in a basal rosette, these and larger stem leaves (1) 3–7 × (0.4) 2–3 cm, 1–3 times pinnatifid-divided, reduced

upwards, usually withering as the fruits develop. Fruiting pedicels usually ascending to horizontal, 4–18 (23) mm long. Inflorescences of racemes (3) 5–32 (45) cm long. Petals pale yellow, 1.5 mm long. Fruits (3.5) 4–7.2 × 1.2–1.6 mm, narrowly club-shaped; ovules 16–40 per ovary. Seeds reddish brown, 0.8 mm long, mucilaginous when wet.

Widespread across the flora area, sandy to rocky soils, washes, plains, bajadas, hills, and mountains. It was in the Butler Mountains more than 10,000 years ago.

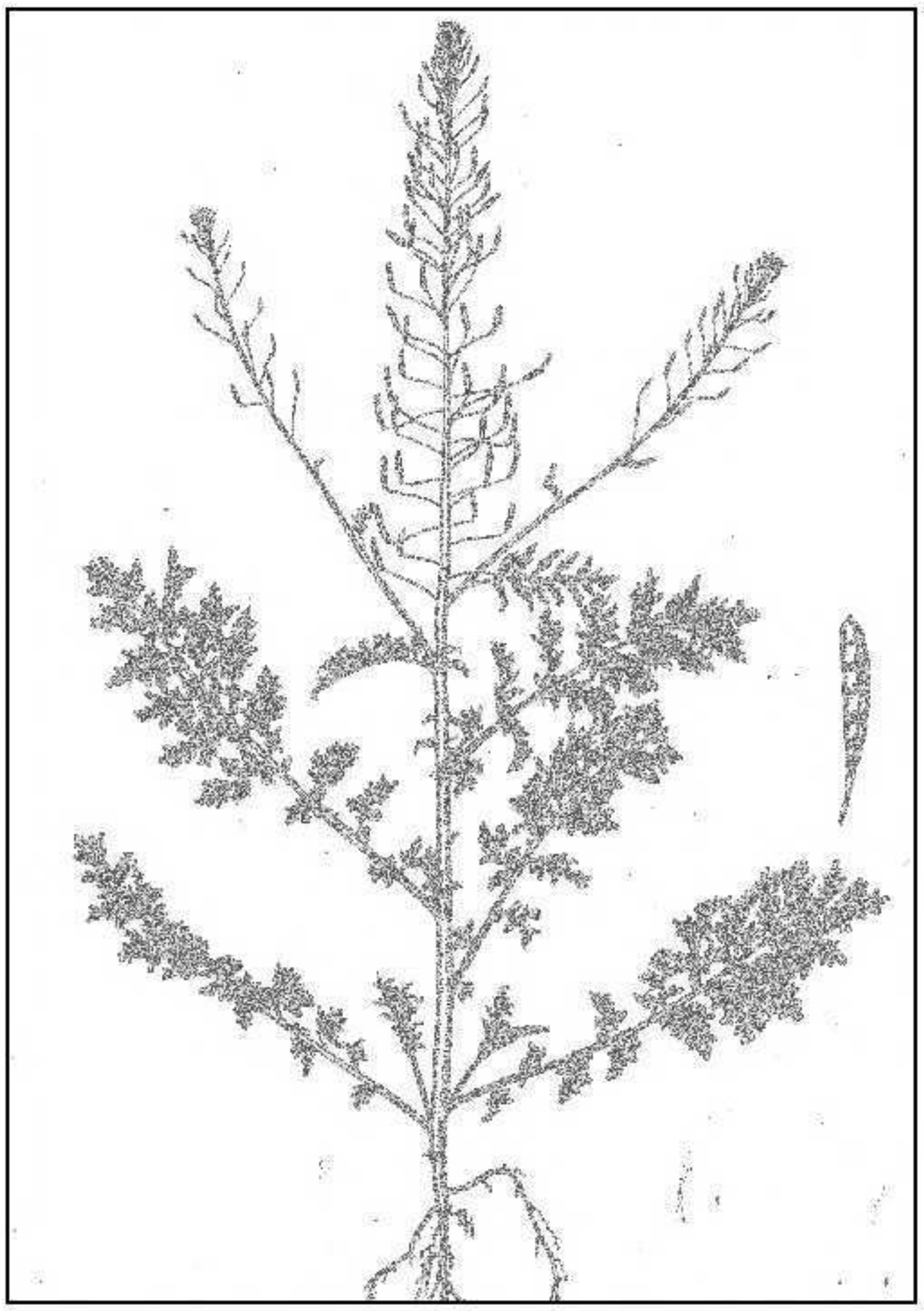

Figure 7. *Descurainia pinnata*. By Lucretia Breazeale Hamilton.

Widespread in North America: Mexico to northern Canada. Four subspecies are sometimes recognized, two of which range into southwestern Arizona: subsp. *glabra* (Wooton & Standley) Detling, not canescent, and subsp. *ochroleuca* (Wooton) Detling, canescent.

The seeds were widely used for food (Bean & Saubel 1972; Felger et al. 1992; Rea 1997). Castetter and Underhill (1935: 24) say that it was "the most common [wild] seed crop" of the Tohono O'odham. Young plants were sometimes boiled as greens or pit-baked by the Quechans (Castetter & Bell 1951). Substantial quantities of the seeds have been found in Hohokam sites, which led Bohrer (1986 in Hodgson 2001) to speculate that it was cultivated. It can be a common weed in cultivated fields, which may have been a source for the Hohokam. The seeds, which become mucilaginous when wet, were widely esteemed for medicinal purposes (Bean & Saubel 1972; Hodgson 2001). Among the Hia C-ed O'odham the "seeds [were] used as food and eye medicine (Delores Lewis) or put in water and drunk for stomach trouble (Philip Salcido)" (Felger et al. 1992: 22–23).

OP: Alamo Canyon, *Nichol 14 Mar 1939*. Quitobaquito, 14 Apr 1963, *Felger 7655*. Near Gachado Line Camp, 28 Jan 1978, *Bowers 1013* (ORPI).

CP: Buckhorn Tank, 27 Feb 1993, *Felger 93-184* (CAB). O'Neill Hills, 12 Mar 1993, *Harlan 359*. Tule Tank drainage, 23 Mar 1993, *Harlan 133* (CAB). Childs Mt, 9 Apr 1993, *Felger 93-277*.

TA: Frontera Canyon, 18 Mar 1998, *Felger* (observation). Coyote Water, 21 Feb 2005, *Felger 05-152*. †Butler Mts, fruit, 10,360 ybp.

****Descurainia sophia*** (Linnaeus) Webb ex Prantl
Figure 8.

Stems upright, single or branched above. Leaves often 3-times dissected into slender lobes. Fruiting pedicels 5–20 mm long. Flowers yellow, the fruits slender, often 12–25 mm long.

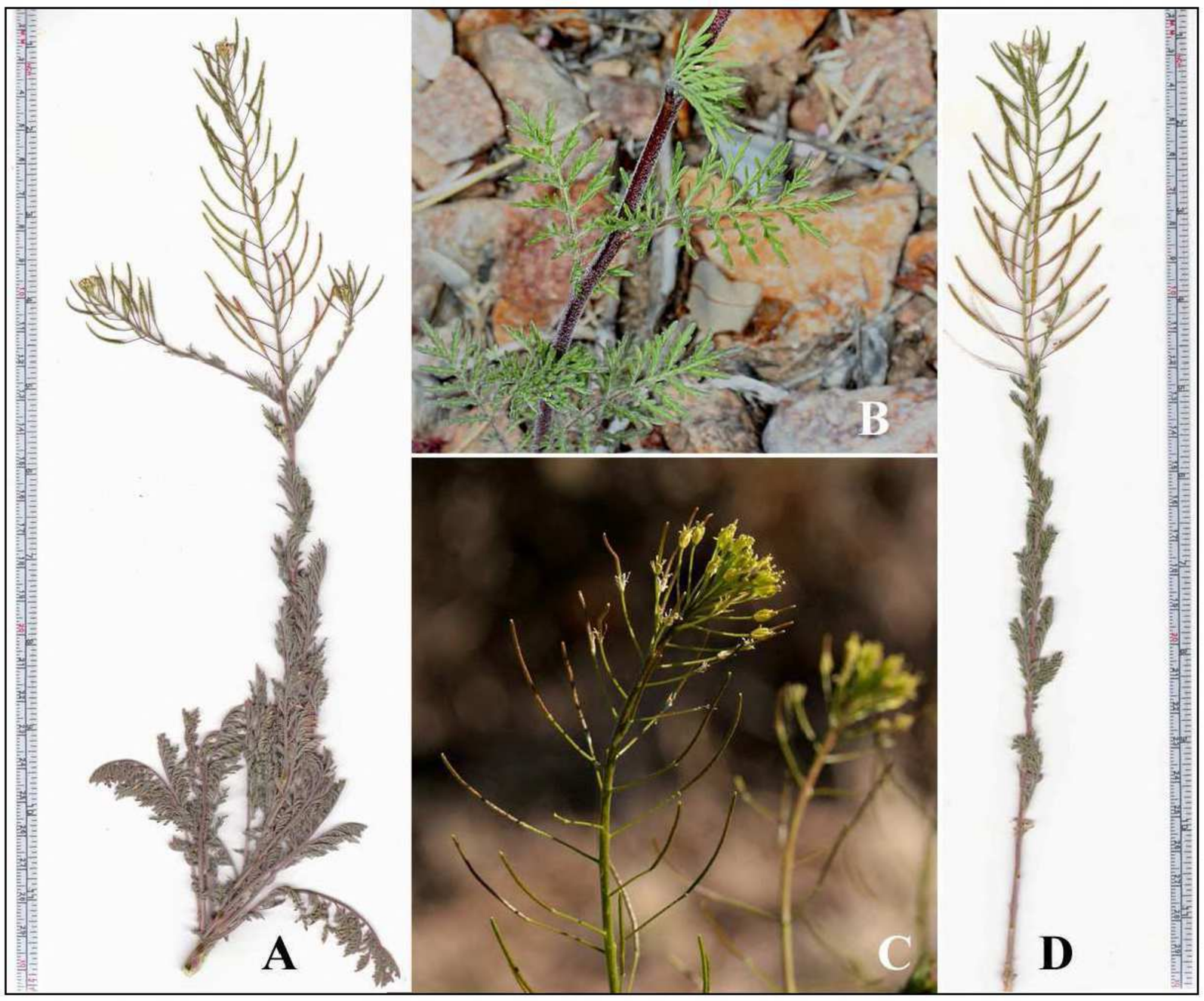

Figure 8. *Descurainia sophia*. (A & D) Construction site, Hwy 85 at 2 mi S of N boundary of Organ Pipe, 12 May 2010. (B) Silver City, Grant Co., NM, 29 Mar 2009, photo by Russell Kleinman (gilaflora.com). (C) Valley of Fires Recreation Area, Lincoln Co., NM, 2 Apr 2007, photo by Patrick Alexander.

Found at a construction site along Highway 85 in Organ Pipe and not established in the floral area.

Widespread weed in North America and elsewhere; native to Eurasia.

OP: Road shoulder of State Route 85, northern 3 mi of highway in Organ Pipe (between milepost 58 and 61), *Rutman 4 Jun 2010*.

Dimorphocarpa – Spectacle-pod

Southwestern United States and northern Mexico; 4 species.

Dimorphocarpa pinnatifida Rollins
[*Dithyrea wislizeni* Engelmann, in part]
Dune spectacle-pod. Figure 9.

Cool-season ephemerals, erect to ascending, sometimes sprawling to more than 1 m across, gray-green with stellate and candelabra-shaped hairs. Stems leafy. Leaves petioled below, sessile above, linear to narrowly lanceolate, pinnatifid with widely spaced slender lobes, larger leaves (3.5) 4–18 × 0.7–2.6 cm. Flowers on racemes 9–38 cm long. Fruiting pedicels spreading to slightly reflexed, 7–22 mm long. Flowers fragrant, attracting butterflies, the petals 5–7 mm long, pure white, the stigma and anthers yellow (corollas thus appear to have a yellow throat). Fruits of 2 disc-shaped indehiscent segments, each 5.5–8.2 mm wide and 1-seeded, the fruits turned at an angle to the pedicel. Seeds disc-like, 2–3.5 mm in diameter. The flowers are smaller and the plants often much larger than those of *Dithyrea californica*, the other spectacle-pod in the region. $x = 9$

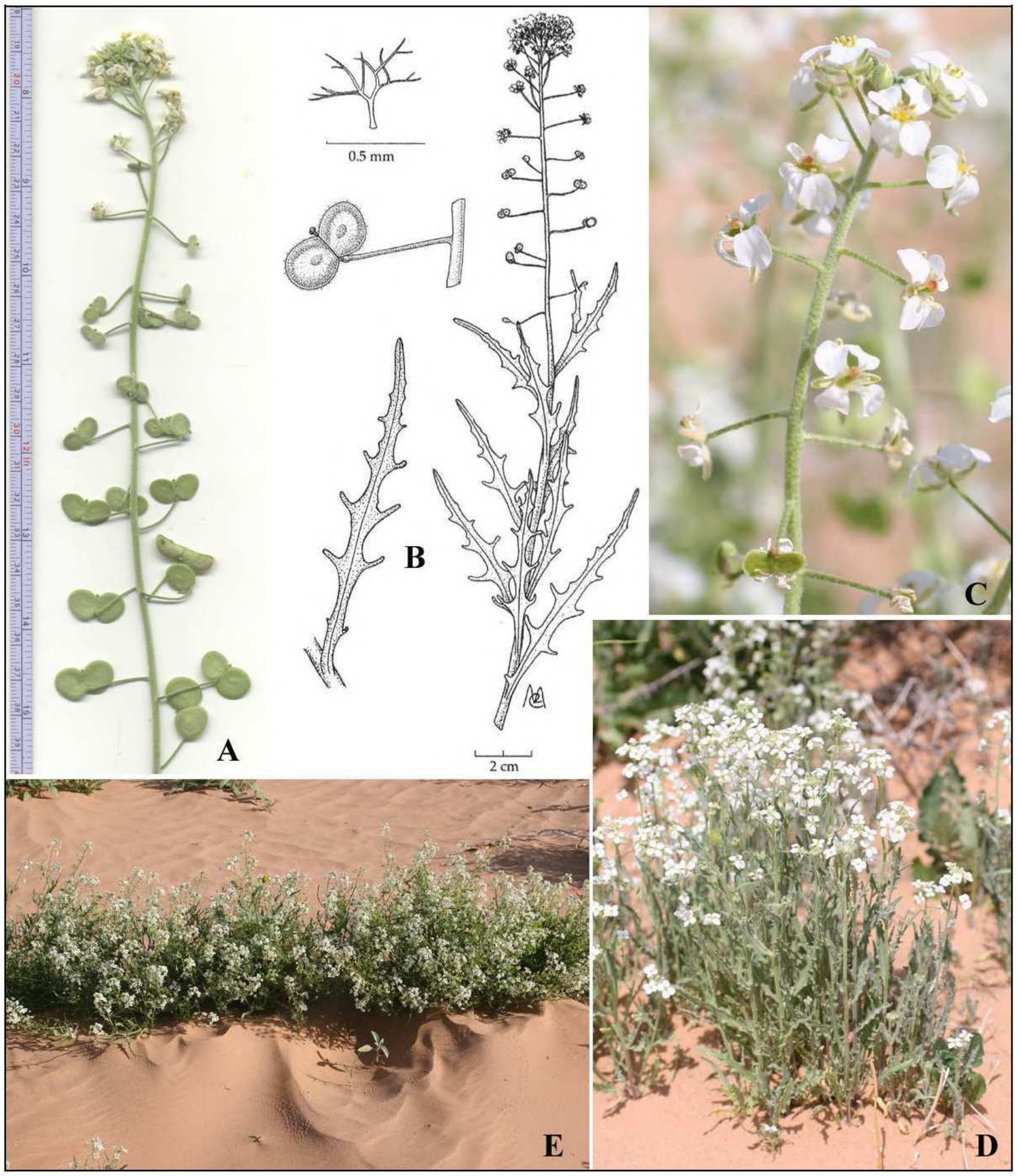

Figure 9. *Dimorphocarpa pinnatifida*. (A) Dunes, 22 mi SW of Sonoyta, Sonora, 6 Feb 2014. (B) By Matilda Essig. Dunes S of Sierra Blanca, Pinacate Biosphere Reserve, Sonora: (C & D) 15 Feb 2010; (E) 23 Feb 2010.

Pinta Sands and Mohawk Dunes, and more widespread on dunes in nearby northwestern Sonora. One plant seen at higher elevation in the Tinajas Altas Mountains and apparently not reproducing.

Endemic to dunes and adjacent sands in Yuma County, including the Mohawk Dunes, and the Gran Desierto of northwestern Sonora (Felger 2000; Felger et al. 2003). Related to, and narrowly allopatric from, the widespread *D. wislizeni* (Engelmann) Rollins in AZ, CO, NM, NV, UT, Chihuahua, and Coahuila. *Dimorphocarpa pinnatifida* can be distinguished from *D. wislizeni* by having upper stem leaves pinnately lobed and fruit valves orbicular and rounded apically.

CP: Pinacate Lava Fields, 20 Mar 1933, *Shreve 6218*. E edge of Pinacate Lava Flow, 17 Apr 1983, *Hodgson H 2081* (DES). 6.6 mi W of O'Neill's Grave, 18 Feb 1979, *Phillips 79-53* (ASU). Pinta Sands: 18 Feb 1979, *McLaughlin 1947*; 1 Feb 1992, *Felger 92-27*.

TA: Tinajas Altas, canyon bottom above uppermost tinaja, one large plant seen, no fruit setting, 19 Mar 1998, *Felger 98-138*.

Dithyrea – Spectacle-pod

Southwestern United States and northwestern Mexico; 2 species.

Dithyrea californica Harvey

[*D. californica* var. *clinata* (Macbride & Payson) Wiggins; *D. clinata* Macbride & Payson]

California spectacle-pod. Figure 10.

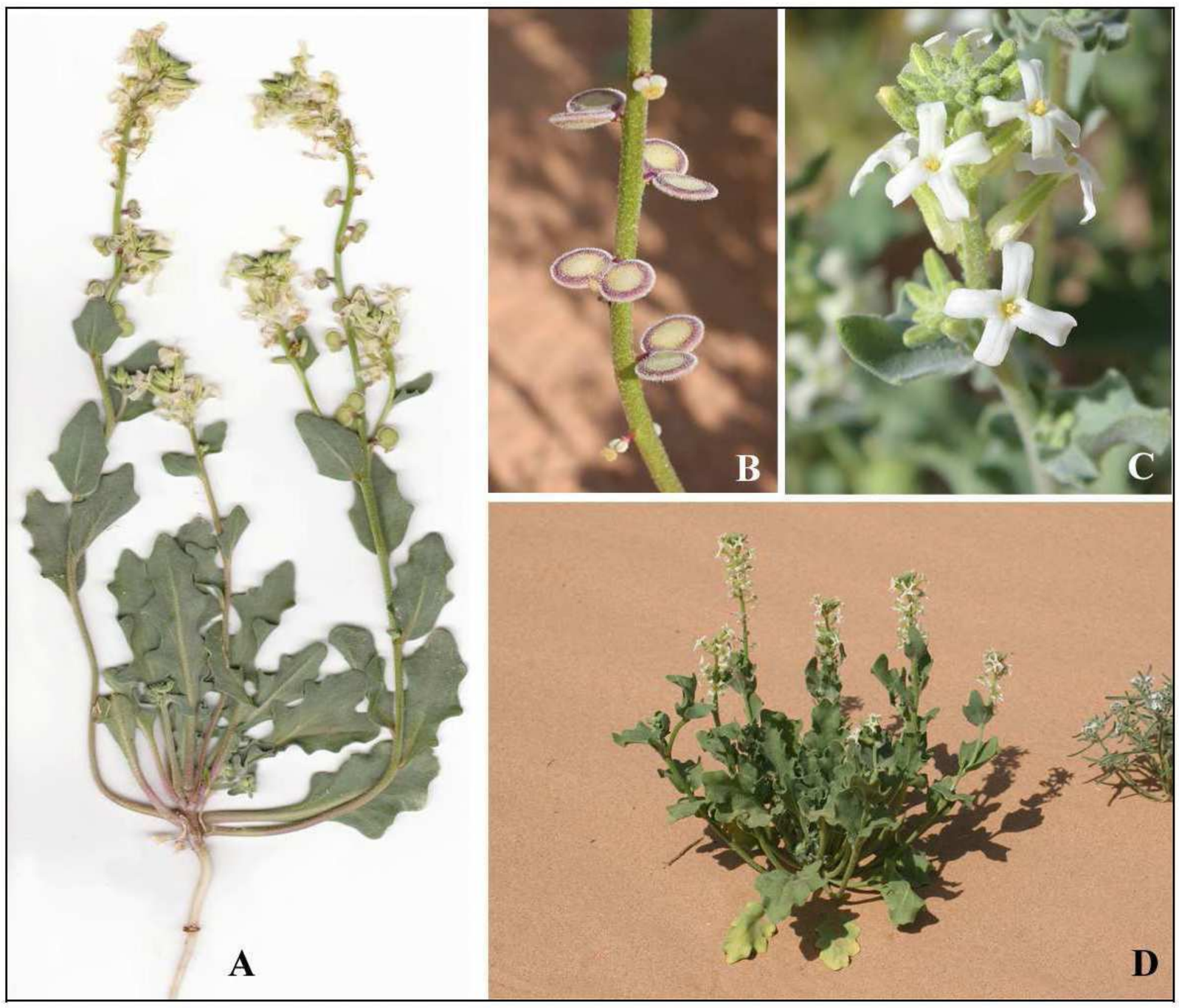

Figure 10. *Dithyrea californica*. (A, B & D) Dunes, 20 mi SW of Sonoyta, Sonora, 27 Mar 2010. (C) Dunes S of Sierra Blanca, Sonora, 15 Feb 2014.

Cool-season ephemerals. Stems 15–50 cm tall, mostly branching from the base. Herbage with slender-rayed, candelabra-shaped white hairs. Leaves semi-succulent when young, basal rosette and lower leaves with large, broad, coarse teeth or lobes, 4.5–15.5 cm long, petioled, more or less oblanceolate to oblong, the upper leaves sessile, ovate to broadly oblong. Fruiting pedicels 1.5–2.5 mm long. Flowers highly fragrant, the petals 10–12 mm long, cream-white, strap-shaped, partially recurved, twisted, and crenulate (wavy). Fruits spectacle-shaped, of 2 halves (valves), each half 4.5–6.5 mm wide, indehiscent, orbicular to slightly wider than long, strongly flattened, and 1-seeded, with simple, thickened (sac-like or vesicular) hairs especially dense on the cord-like margin. Seeds 3–4 × 1.5–2.5 mm.

Sand flats and dunes, and sand soils in the Pinacate Lava in the southern part of Cabeza Prieta, especially the Pinta Sands.

Sonoran and Mojave Deserts in northwestern Sonora, western Arizona, southeastern California, southern Nevada, and both Baja California states. Distinguished in part from *Dimorphocarpa* (the other spectacle pod) by having a chromosome number based on $x = 10$, coarser leaf lobes, stouter and shorter pedicels, and larger flowers.

CP: Pinacate Plateau, *Goodding 29 Nov1938*. Monument 182, *Monson* 7 Feb 1958. W edge of sands W of Pinacate Lava, 17 Jan 1964, *Simmons 12*. Pinta Sands: 10 Apr 1978, *Reeves 6793* (ASU); 1 Feb 1992, *Felger 92-28*. San Cristobal Valley, 11 Mar 1998, *Anderson 98-36* (ASU).
TA: Butler Mts, *Van Devender 27 Mar 1983*.

Draba cuneifolia, see **Tomostima cuneifolia**

***Eruca**

This genus has a single species.

***Eruca vesicaria** (Linnaeus) Cavanilles subsp. **sativa** (Miller) Thellung
[*E. sativa* Miller; *Brassica eruca* Linnaeus]
Garden rocket, salad rocket, arugula. Figure 11.

Cool-season ephemerals (15) 50–70+ cm tall, with simple white hairs. Early leaves in a basal rosette, 6–20+ × 3–10+ cm, pinnately lobed. Flowers on erect stalks, the petals to 17 mm long, pale yellow often fading to white, and with purple veins, narrowed at base (clawed). Fruiting pedicels 4.5–6.7 mm long, erect; fruits terete and rather stout, longer than wide, erect, and dehiscent; fruit body 17–20 (40) × 2.5–5 mm, with a prominent flattened, seedless beak 6–7 mm long. Seeds pale or grayish brown, mucilaginous when wet.

Common in areas to the north and south of flora area and found as occasional waifs in Organ Pipe where it is likely to spread.

Widely naturalized in southwestern Arizona, mostly but not exclusively near roads; especially abundant during El Niño years when it can blanket the desert along I–8 and adjacent areas from Gila Bend to Wellton. It is likewise common during wet winters in the Sonoyta and San Luis regions of northwestern Sonora. However, in 2014 it was still not established at Ajo.

Native to the Mediterranean region, now widespread and weedy from Canada to southern Mexico and many regions worldwide. It has been in Arizona since at least the early 20th century. Cultivated arugula is a popular salad green and has been cultivated since ancient times, including by the Greeks and Romans. The seed oil is used for cooking, as animal food, as an industrial lubricant, and for cosmetics and medicinal purposes (Al-Shehbaz 1985; Warwick 2010).

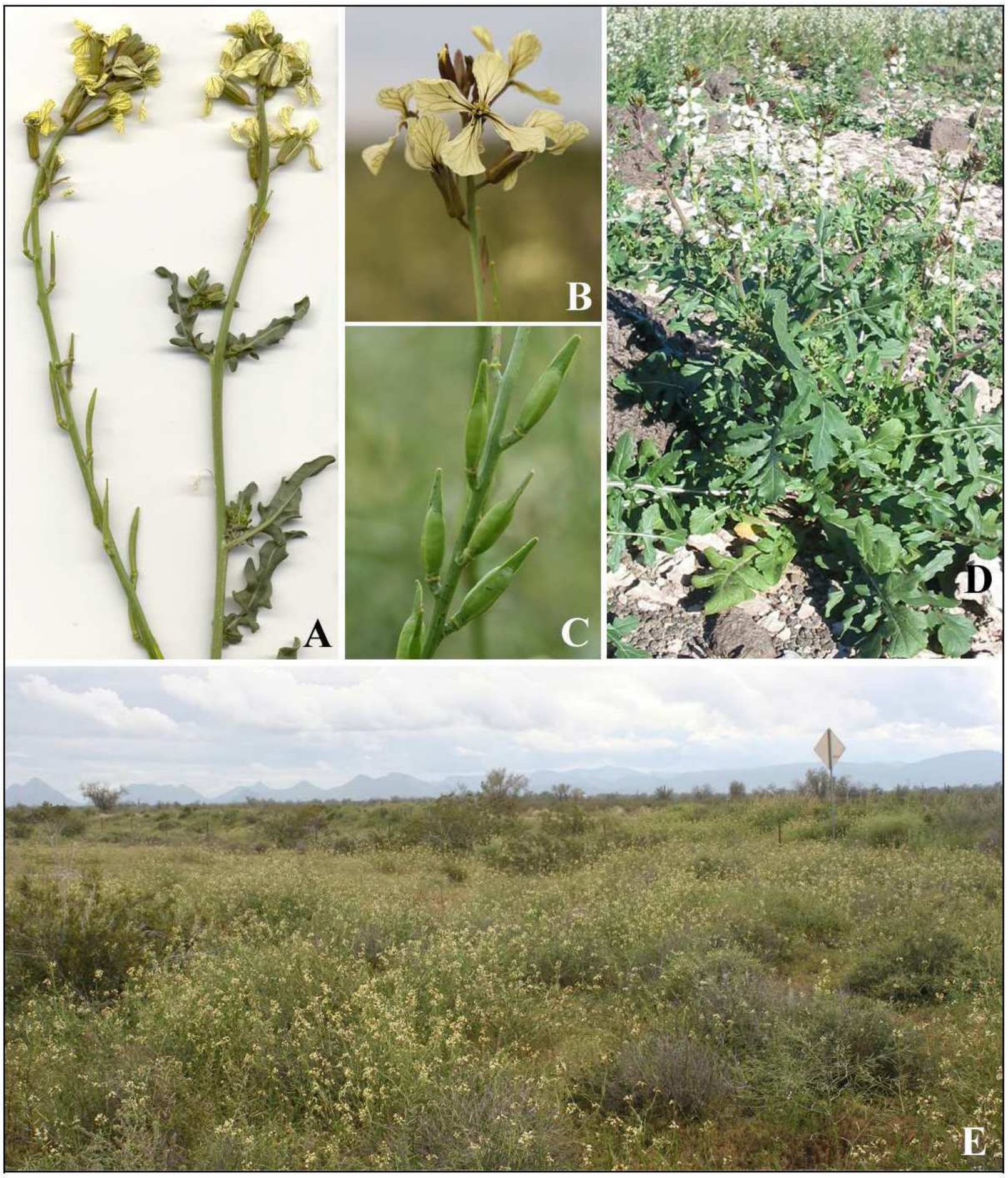

Figure 11. *Eruca vesicaria* ssp. *sativa*. Gila Bend, Maricopa Co.: (A) 4 Apr 2002; (B, C & E) Mar 2005. (D) Cinder hills, Sentinel Plain, Maricopa Co., 17 Jan 2005.

OP: Bates Well Rd, 1 mi S of N boundary of Monument, UTM 319371, 3562940, 1493 ft, two plants occurred on the berm of the road, in disturbed soil, *Conner 16 Feb 2005*.

Erysimum – Wallflower

North America to Central America, Eurasia, North Africa, and Atlantic islands; 200 species.

Erysimum capitatum (Douglas ex Hooker) Greene
[*E. capitatum* var. *purshii* (Durand) Rollins]
Western wallflower. Figure 12.

Cool-season ephemerals, or perhaps short-lived perennials, usually tall and slender. Leaves linear to oblanceolate, 2–18+ cm long, with 2–4 (7)-rayed hairs, the margins entire or toothed. Fruiting pedicels spreading to ascending, narrower than the fruit, 4–17 (25) mm long. Flowers

showy, the petals yellow, 15–25 mm long. Fruits 4–10 cm long, 1–2 mm wide, 4-angled to slightly flattened; ovules (40) 50–82 per ovary.

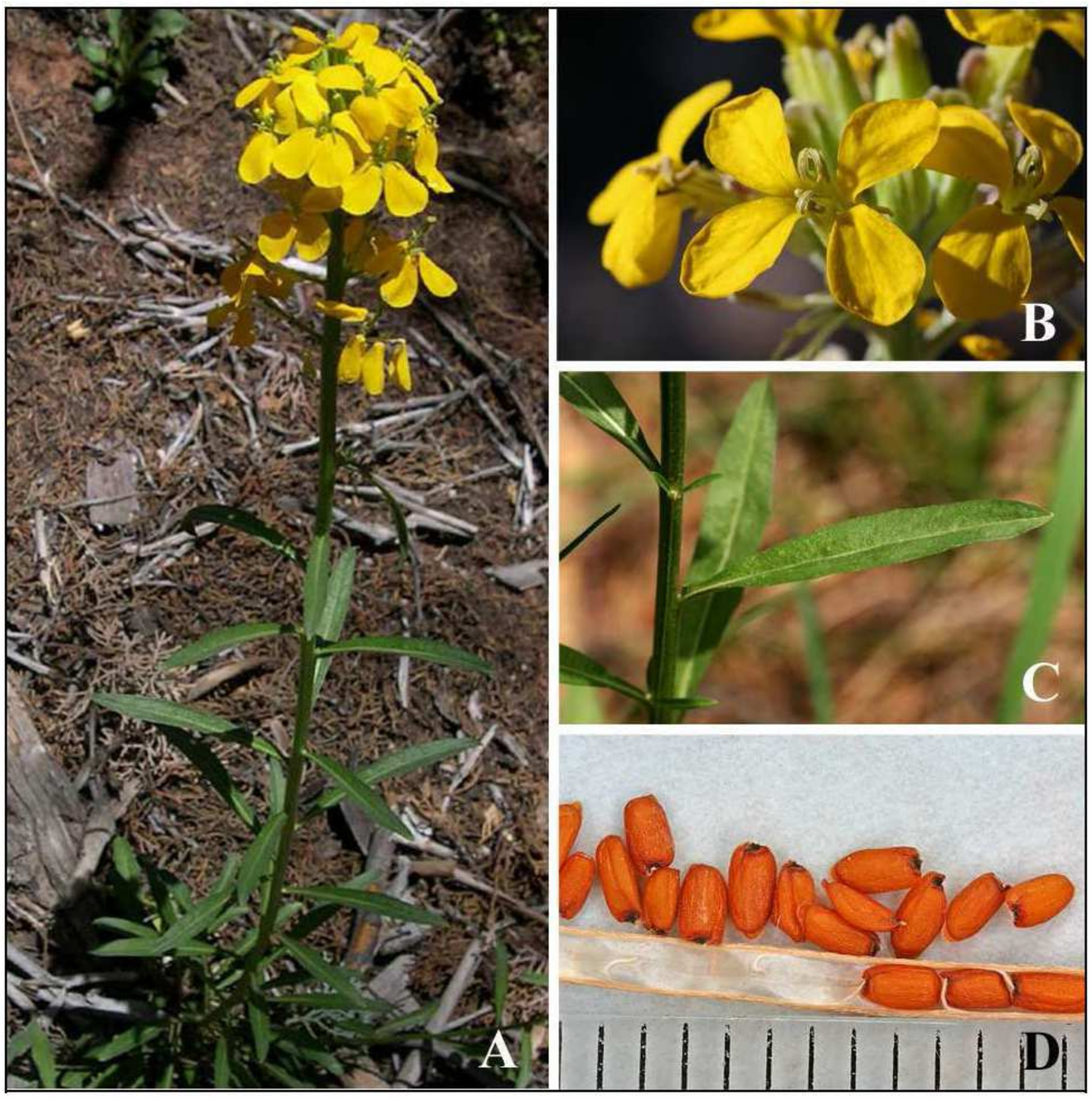

Figure 12. *Erysimum capitatum*. (A) Wilson Canyon, N of Sedona, Coconino Co., 3 Mar 2004, photo by Max Licher (SEINet). (B) Pancho Canyon, Burro Mts, Grant Co., NM, 7 Nov 2008, photo by Russell Kleinman (gilaflora.com). (C) Bluff Spring, Sacramento Mountains, Otero Co., NM, 16 Jun 2007, photo by Patrick Alexander. (D) Seeds and silique, Pinos Altos, Grant Co., NM, 8 Feb 2009, photo by Russell Kleinman (gilaflora.com).

Known in flora area from a single record in the Ajo Mountains. The specimen has T-shaped (2-armed) hairs on the leaves, aligning it with var. *purshii*, although the varieties are probably not worthy of recognition.

A morphologically diverse and widespread species in non-desert regions of Arizona and generally absent from the Sonoran Desert. North America from Alaska to central Mexico.

OP: Alamo Canyon, *Tinkham 15 Apr 1942*.

Hesperidanthus

Perennials or subshrubs. Western United States and northern Mexico; 5 species.

Hesperidanthus linearifolius (A. Gray) Rydberg
[*Schoenocrambe linearifolia* (A. Gray) Rollins; *Sisymbrium linearifolium* (A. Gray) Payson; *Thelypodiopsis linearifolia* (A. Gray) Al-Shehbaz]
Purple rock-mustard. Figure 13.

Glabrous, erect perennials to more than 2 m tall from a caudex. The stem leaves linear to lanceolate, 2.5–10 (15) cm long, entire or nearly so and relatively thick. Petals purple, with age becoming white, 12–16+ mm long. Flowering February to May and after summer rains in August and September. Fruiting pedicels spreading to ascending, 5–25 mm long. Fruits 4–10 cm long, 1–1.5 mm wide, terete, not constricted between seeds; ovules 76–110 per ovary.

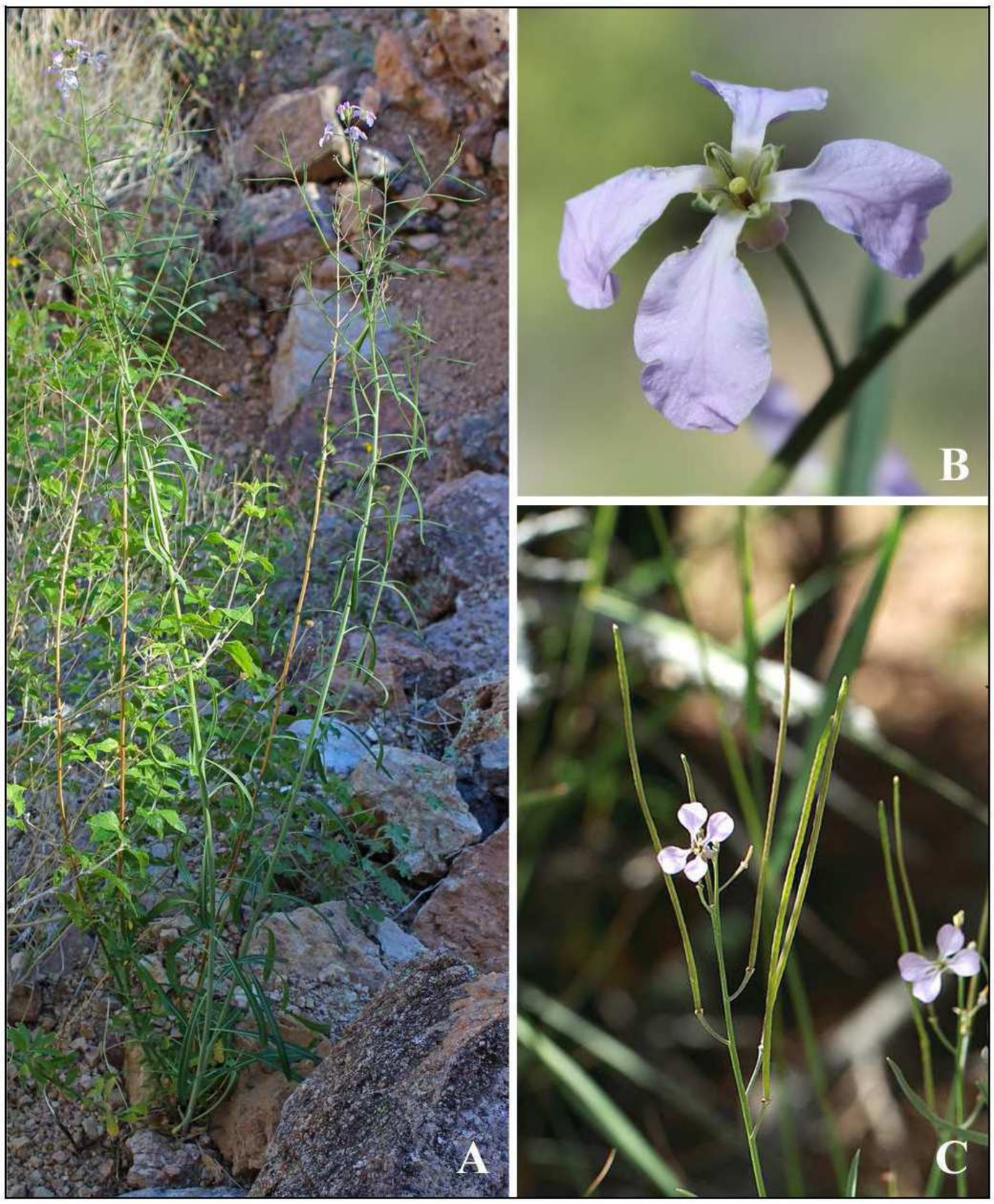

Figure 13. *Hesperidanthus linearifolius*. Estes Canyon, Bull Pasture Trail: (A) 7 Mar 2014; (B) 27 Feb 2014. (C) Allie Canyon near Mimbres, Pinos Altos Mts, NM, 8 Sep 2010, photo by Russell Kleinman (gilaflora.com).

Widespread in the Ajo Mountains above 730 m and higher elevations in the Puerto Blanco Mountains.

Arizona and Sonora at elevations generally above the desert, to Colorado, Texas, and northern mainland Mexico to San Luis Potosí, Durango, and Zacatecas.

OP: Alamo Canyon, *Nichol 4 May 1939*. Arch Canyon, 28 Mar 1965, *Niles 539*. Grass Canyon, 26 Feb 1978, *Bowers 1090*. Rare in shady spots on upper slopes of Puerto Blanco Mts, NW of Pinkley Peak, 2500 ft, *Rutman 24 Mar 2001* (ORPI). Trail from The Cones to Mount Ajo, 4025 ft, 10 Apr 2005, *Felger 05-274*.

Lepidium – Peppergrass, pepperwort, cress, peppercress; *lentejilla*

Cool-season ephemerals, glabrous or with simple hairs. Flowers small, with white petals, these often reduced or the petals might be absent and the flowers selfing (autogamous). Fruits small and disc-shaped. Seeds highly mucilaginous when wet.

The herbage, flowers and fruits have a sharp, pepper- or chili-like flavor and can be used as a condiment. Nearly worldwide; 250 species.

1. Pedicels terete and slender; petals 2–3 mm long, white and conspicuous, not quickly deciduous, as large or larger than the sepals; stamens 6; styles longer than the apical fruit margin. ..... **Lepidium thurberi**
1. Pedicels moderately to strongly flattened; petals less than 1.5 mm long, whitish but rather inconspicuous, quickly deciduous, smaller and thinner than the sepals, or rudimentary or sometimes absent; stamens mostly 2 with additional rudimentary stamens (4 or 6 stamens sometimes present); stigma sessile or nearly so, or the styles short and not exceeding the apical fruit margin (see notes farther on).

    2. Fruiting pedicels strongly flattened, usually pubescent on both the upper and lower surfaces; sepals usually quickly deciduous; fruits usually pubescent, sometimes only on the margins, the apical notch 0.2–0.7 mm deep..... **Lepidium lasiocarpum**
    2. Fruiting pedicels only slightly flattened, pubescent on the upper surfaces, glabrous on the lower surfaces; sepals tardily deciduous to somewhat persistent; fruits usually glabrous, the apical notch 0.2–0.3 mm deep..... **Lepidium oblongum**

Lepidium lasiocarpum Nuttall ex Torrey & A. Gray
[*L. lasiocarpum* var. *georginum* C.L. Hitchcock]
Sand peppergrass; *lentejilla*; ka:kowani. Figure 14.

Plants hirsute or hispid, 5–20 (40) cm, larger plants much-branched. Early leaves in a basal rosette, 2.5–6+ cm long, oblanceolate, bipinnatifid, quickly withering as stems develop; stem leaves smaller. Racemes mostly 2–10+ cm long, often crowded on larger plants. Fruiting pedicels conspicuously flattened (even on buds), usually pubescent on both the upper and lower surfaces. Flowers inconspicuous, probably mainly autogamous (selfing); sepals 1–1.5 mm long; petals white, quickly deciduous, smaller and thinner than the sepals, rudimentary, or sometimes absent; stamens 2 (4 or 6; abortive stamens often present on flowers with fewer than 6 stamens). Fruits nearly orbicular, strongly compressed (flattened), 3–4 mm long, notched at the apex, producing a relatively deep sinus with an essentially sessile stigma at its base, which seems to be a reliable key character.

One of the most common and widespread winter-spring ephemerals, mostly in washes and flats, and less common on rocky slopes. It has been in the region for at least 10,400 years.

Southwestern United States and northwestern Mexico.

The herbage of this and other species in the genus has been used in many places as a spicy condiment, hence the name "pepper grass," and as cooked greens or for salads (Hodgson 2001; Uphof 1968). The Seris used it for the chili-like flavor (Felger & Moser 1985). Chew on the fresh herbage or dry fruits and seeds and you will get a pleasantly sharp chili flavor.

The plants are highly variable depending on factors such soil moisture, shading, and stage of development. Young, vigorous plants can be very leafy, while older or drought-stressed plants are leafless or nearly so, and there is likewise much variation in pubescence, size and/or number of petals, and number of stamens. The flowers are autogamous but perhaps not always, especially with

favorable conditions. This variation seems to have led to problems in identification. Rollins (1993) recognizes four varieties and Al-Shehbaz and Gaskin (2010) recognize 3 subspecies, but the varieties seem only weakly differentiated and not worthy of recognition.

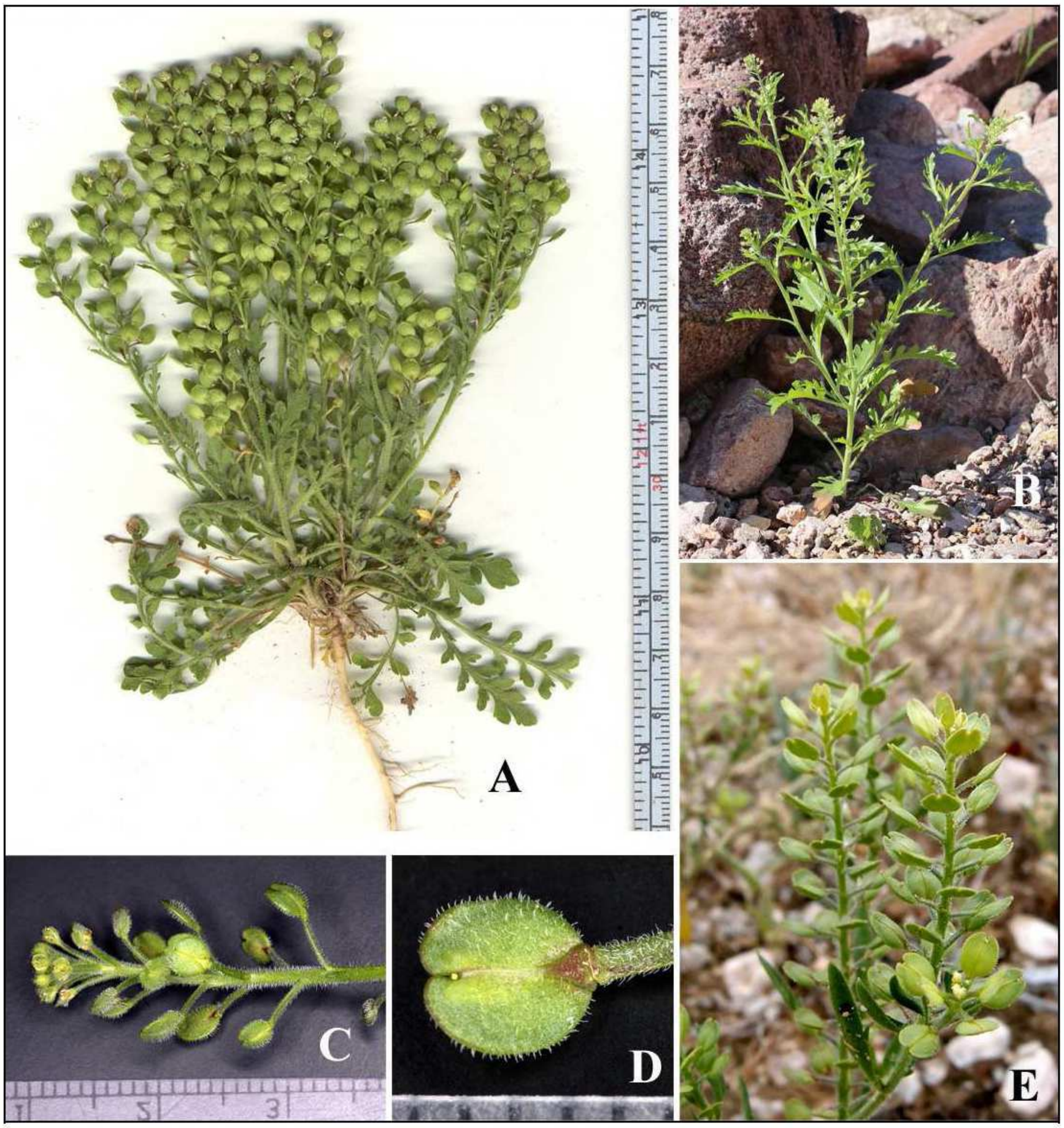

Figure 14. *Lepidium lasiocarpum*. (A) Ajo, 25 Mar 2013. (B) Alamo Canyon, 26 Feb 2014. (C & D) Engineer Canyon, Burro Mts, Grant Co., NM, 17 Mar 2010, photos by Russell Kleinman (gilaflora.com). (E) East of Tinajas Altas, 2 Mar 2014, photo by Sue Carnahan.

We are unable to realistically distinguish *Lepidium densiflorum* Schrader from *L. lasiocarpum*. These plants are often autogamous and polyploids of hybrid origin can be weakly differentiated, or sometime well differentiated. Environmental factors may also play a role in the confusing array of variability. Some populations that might be placed with *L. densiflorum* appear morphologically intermediate with between *L. lasiocarpum* and *L. virginicum* Linnaeus, raising the speculation that the plants might be of hybrid origin. *Lepidium virginicum* is widespread and occurs in Arizona east of the flora area.

We have been struggling with aspects of northern Mexico and southern Arizona *Lepidium* taxonomy for some time. A paragraph from Hitchcock's article (1945: 133) echoes what we have found in trying to figure out this taxonomic tangle:

> In general, *L. lasiocarpum* can be recognized from our other species because of the pubescent fruits, stiff pubescence, and flattened pedicels. However, the species is apparently in an extremely unstable condition, and great variation is to be found in every attribute, which has been thought to characterize it. Especially is this true in Mexico where it simulates or actually merges with such apparently different species as *virginicum* (var. *pubescens*), *densiflorum*, *dictyotum*, and *oblongum*, the evidence indicating that this is due in part, at least, to hybridization.

We agree with Hitchcock and what can, for the most part, be sorted out in Arizona falls to pieces in Mexico. For example, when you look at specimens variously identified as *L. densiflorum*, *L. lasiocarpum*, and/or *L. virginicum* you find every conceivable intermediate between all of them, so that separation is only artificial along a continuum. What makes this problem irritating from a taxonomic point of view makes it interesting from an ecological and evolutionary standpoint. We might ask: What is the distinction here between "hybridization" and points on a continuum of intergrading variation?

OP: Growler Valley, 20 Mar 1933, *Shreve 6203*. Canyon Diablo, 21 Mar 1935, *Kearney 10826*. Puerto Blanco Mts, *Nichol 25 Feb 1939*. Alamo Canyon, 14 Mar 1941, *Benson* 10674; 23 Mar 1941, *McDougall 22*. Dripping Springs, 28 Jan 1978, *Bowers 1018*. Arch Canyon, 3050 ft, 25 Feb 1978, *Bowers 1063*. Gachado Line Camp, 28 Jan 1978, *Bowers 1014*. Quitobaquito, 14 Apr 1963, *Felger 7679*. †Alamo Canyon, fruits, one with a flattened pedicel, 8130 ybp.

CP: Charlie Bell Well, *Johnson 26 Mar 1960*. 12 mi N of Christmas Pass, 13 Apr 1992, *Harlan 261*. Pinta Sands, 11 Apr 1993, *Felger 93-426*. San Cristobal Wash, 20 Mar 1992, *Harlan 14*.

TA: Tinajas Altas, wash floor above tanks, *Van Devender 10 Mar 1980*. Coyote Water, 21 Feb 2005, *Felger 05-130*. †Butler Mts, fruits with flattened pedicels, seeds, 8160 & 10,360 ybp.

Lepidium oblongum Small
Veiny pepperweed

Annuals, hirsute. Stems usually several from base, ascending, erect, to decumbent, to 30 cm long. Basal leaves not rosette forming, petiolate, once to twice pinnatifid, to 3.5 cm long. Fruiting pedicels 2–3.5 (5) mm long, pubescent on the upper surfaces, glabrous on the lower surfaces. Flowers inconspicuous, probably mainly autogamous, the sepals tardily deciduous to somewhat persistent, ca. 1 mm long, the petals absent or rudimentary, the stamens 2, the anthers minute. Fruits strongly compressed (flattened), orbicular, 2.2–3.5 × 2–3 mm, the style essentially sessile and included in the apical notch.

In the flora area known from Quitobaquito and Gunsight when both places were occupied.

California to Alabama, Mexico to Central America; washes, roadsides and other disturbed areas. Easily confused with, but less common than *Lepidium lasiocarpum,* with which it sometimes grows sympatrically and may hybridize.

OP: Quitobaquito, 17 Mar 1945, *Darrow 2406*.
Pima Co.: Gunsight, 3 mi E of Organ Pipe Cactus Nat. Mon., 14 Mar 1941, *Benson 10645*.

Lepidium thurberi Wooton
Arizona peppergrass. Figure 15.

Ephemerals or annuals, often from one stem and branched above, pubescent with white hairs to 1 mm long. Basal leaves in a rosette, often withered by flowering time, to 15 cm long, the blade pinnatifid with toothed-sinuate margins. Fruiting pedicels slender and terete, ascending to horizontal, 4–10 mm long. Flowers attractive, the petals white, 3–4 mm long; stamens 6. Fruits strongly compressed (flattened), glabrous, ovate to orbicular, 2–2.9 × 2–2.8 mm, the style 0.3–0.8 mm long, extending beyond the apical notch.

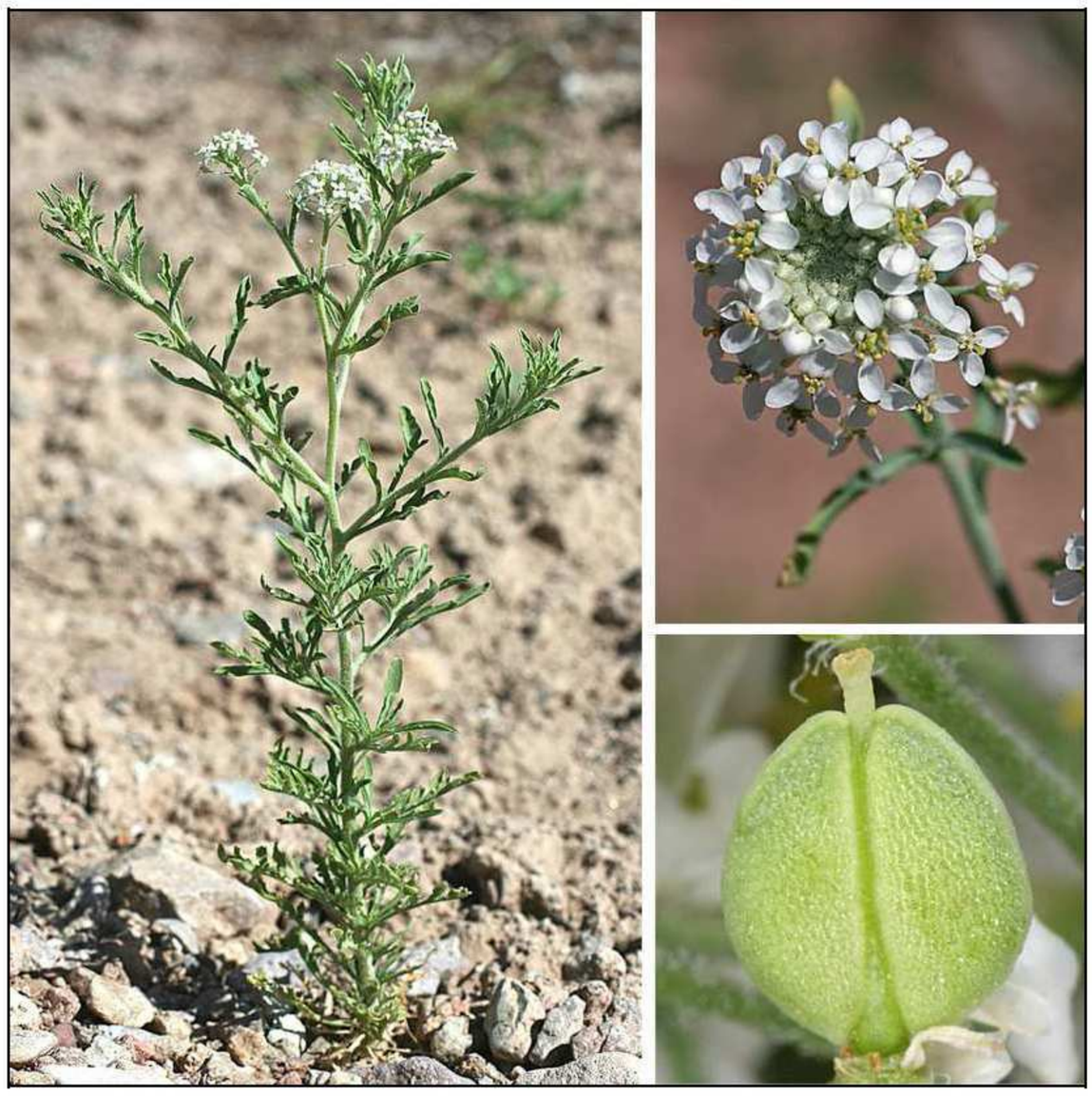

Figure 15. *Lepidium thurberi*. Newby Road, Burro Mts, Grant Co., NM, 7 Jun 2009, photos by Russell Kleinman (gilaflora.com).

Northern part of Organ Pipe, and perhaps the eastern margin of Cabeza Prieta near Jose Juan Hill. The seeds were eaten in the Tohono O'odham Region (Castetter & Underhill 1935).

California to New Mexico, Sonora, Chihuahua, and Coahuila.

OP: Near Bates Well, 25 Mar 1941, *McDougall 32*. Organ Pipe, *Walden 19 Apr 1964*. Cuerda de Leña Wash at N boundary, 31 Mar 1978, *Bowers 1158*. Jose Juan Hill, *Jackson? 7 Mar 1986* (ORPI).

†Lepidium sp./spp.

One or more members of this genus have been in the flora area for more than 18,700 years.

OP: †Puerto Blanco Mts, 980 to 10,540 ybp (4 samples).
TA: †Butler Mts, fruit (shaped like that of *L. lasiocarpum*), 11,250 ybp. Tinajas Altas, fruits, seeds, 8700 to 18,700 ybp (5 samples).

Lyrocarpa

Southwestern United States and northwestern Mexico; 3 species.

Lyrocarpa coulteri Hooker & Harvey
Lyre-pod; ban censañig. Figure 16.

Weak-stemmed herbaceous perennials, sometimes flowering in the first season; with stellate or candelabra-shaped hairs. Growing and flowering at various seasons with sufficient moisture. Stems slender and brittle, often 30–75 cm long. Leaves petioled, variable depending on shading, soil moisture, and position on stem, the blades thinner during wet periods, mostly 2.5–7 (11) cm long, pinnately lobed to deeply divided, mostly with (2) 3 (4) pairs of major segments. Flowers on racemes (4) 7–45 cm long; petals often twisted, linear-attenuate, extending 12–20 mm beyond the calyx, yellow-green, or yellow-brown to purple-brown, becoming darker with age. Fruits 10–28 × 8–14 mm, highly variable, broadly eliptic, obovate, or lyre-shaped, green, compressed but relatively thick, usually notched and widest at top. Seeds not mucilaginous.

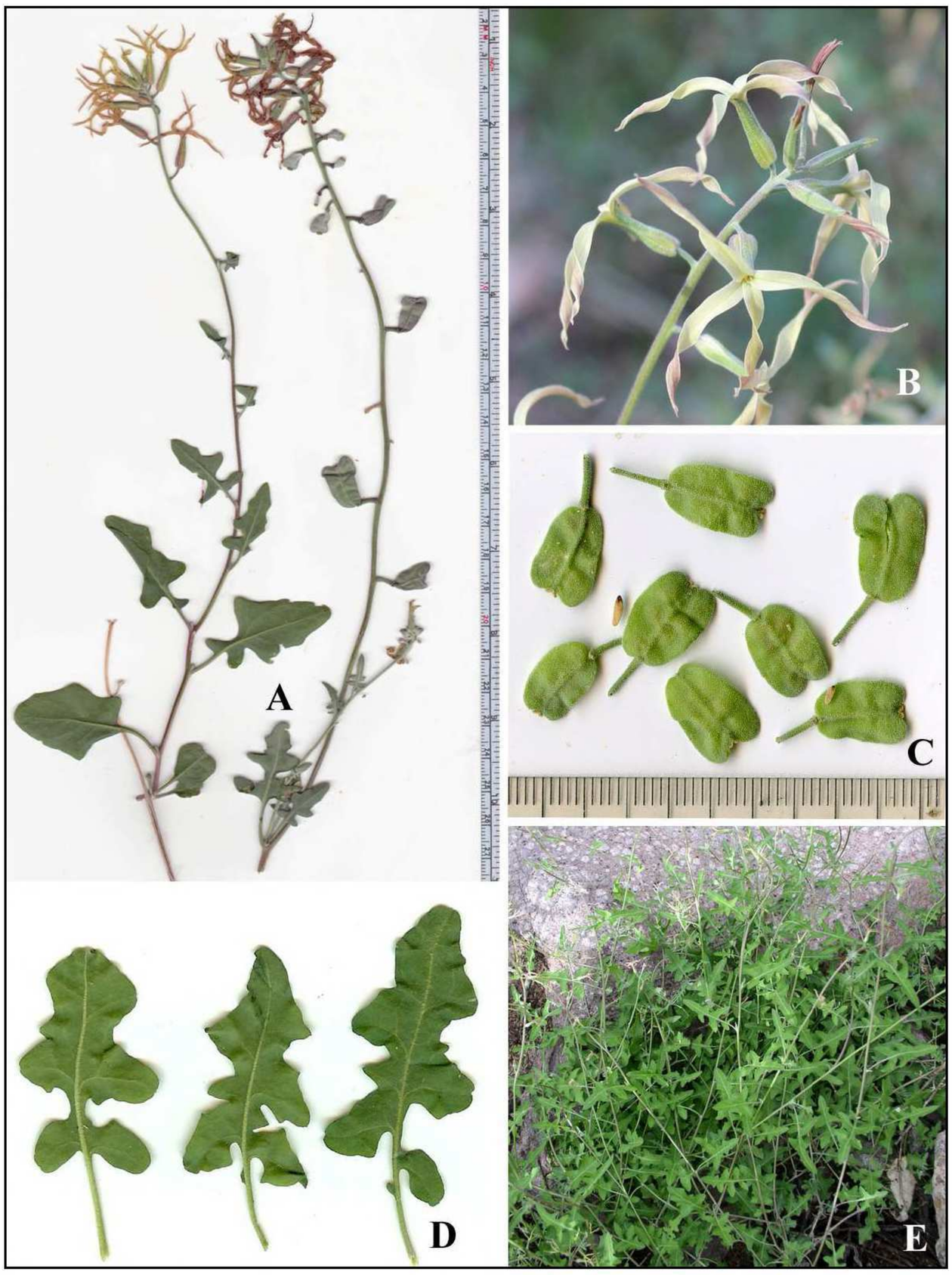

Figure 16. *Lyrocarpa coulteri*. Estes Canyon: (A) 3 Apr 2010; (B) 30 Jan 2014; (C & D) 29 Feb 2008; (E) 16 Feb 2005.

The flowers are especially fragrant at night. Walking up Eagle Tank Arroyo in Cabeza Prieta at 9:30 p.m. on 26 February 1993, every so often Felger caught a whiff of a strong, strange, sweet fragrance. Up close it was even stronger, like banana esters, and came from perennial mounds of *Lyrocarpa* lining the arroyo bank.

Widespread across the flora area; often growing in the protection of large rocks and beneath shrubs and desert trees such as *Olneya*; washes, canyons, gravelly bajadas, and rocky slopes of hills and mountains.

Southern Arizona, southeastern California, western Sonora southward to the vicinity of Guaymas and both states of Baja California.

Lyrocarpa is the only perennial as well as non-seasonal (flowering and growth response) member of the mustard family that extends into the drier areas of the Sonoran Desert. *Lyrocarpa coulteri* seems to be closely related to *L. linearifolia* Rollins of islands in the Gulf of California.

OP: Alamo Canyon, *Nichol 14 Mar 1939*. Bates Well, 5 Mar 1940, *Benson 9911*. Dripping Springs, 16 Apr 1952, *Parker 7914*. Aguajita, 6 Apr 1988, *Felger 88-277*.
CP: Pinacate Flats, 3 Dec 1935, *Goodding 1554*. Papago Well region, 13 Feb 1942, *Goodding 9-42*. Near Agua Dulce Pass, *Simmons 13 Apr 1964* (CAB). Christmas Pass, *Van Devender 9 Mar 1980*. N side of Tule Mts, 2 Feb 1992, *Felger 92-48*.
TA: Tinajas Altas: 29 Mar 1930, *Harrison 6563; Van Devender 36 Mar 1983*.

***Matthiola**

Native to the Old World; 50 species.

****Matthiola longipetala** (Ventenat) de Candolle
[*M. bicornis* (Sibthorp & Smith) de Candolle]
Night-scented stock. Figure 17.

Figure 17. *Matthiola longipetala*. Hwy 85 near Three Points (Robles Junction), Pima Co., 2 Apr 2005.

Ephemerals with branched hairs. The first leaves not forming a basal rosette. Flowers pink and highly fragrant, especially fragrant at night; petals 15–20+ mm long. Fruits slender and straight, often more than 5 cm long.

Documented in Organ Pipe in the residence area, from a wildflower seed mix, and a single observation that same year on Hwy 85 about 200 meters north of the entrance to the visitor center, and doubtfully established. This species is a beautiful garden plant that produces prolific seed and easily escapes/spreads given suitable rainfall.

Native to Eurasia and sporadically established in North America as far north as Canada, and often cultivated.

OP: Residence area near visitor center, growing from a wildflower seed mix, *Rutman 27 Apr 2005.*

***Nasturtium** – Watercress
North America to Central America, Eurasia, and north Africa; 5 species.

****Nasturtium officinale*** W.T. Aiton
[*Rorippa nasturtium-aquaticum* (Linnaeus) Hayek]
Watercress; *berro.* Figure 18.

Perennial herbs; probably emergent from shallow water, at Dripping Springs and Williams Spring and no longer present in the flora area. Watercress was probably planted at these springs.

Figure 18. *Nasturtium officinale*. (A) Harshaw Creek, Santa Cruz Co., 26 May 2013, photo by Tom Van Devender. (B) Gold Gulch Spring, Burro Mts, Grant Co., NM, 10 Apr 2009, photo by Russell Kleinman (gilaflora.com).

The plants at Dripping Springs were destroyed by the multitudes of illegal border crossers in the latter part of the 20th century. The Williams Spring watercress died out probably sometime before the mid-20th century (Felger et al. 1992).

Native to the Old World; temperate and subtropical regions worldwide and widely cultivated; naturalized in many southern Arizona and northern Sonora streams.

OP: Bobby Gray (*in* Hoy 1970) reported that in the late nineteenth century watercress grew at Williams Spring; Henry Gray (interviewed by Joyce Kelso in 1975, a National Park Service employee; on file at Organ Pipe Cactus National Monument) in talking about watercress at Dripping Springs said, "It was awful good. . . I'd eat a lot of it."

Physaria – Bladderpod

North America and southern South America, and northeast Russia; 106 species.

Physaria tenella (A. Nelson) O'Kane & Al-Shehbaz
[*Lesquerella tenella* A. Nelson]
Desert bladderpod. Figure 19.

Cool-season ephemerals, silvery green from a covering of stellate hairs that are spectacular under high magnification. Stems mostly 15–60 cm long. Basal-rosette leaves and lower stem leaves often 3–9 cm long, petioled, the blades narrowly elliptic to obovate. Fruiting pedicels S-shaped, often (10) 15–18 mm long. Flowers in racemes (3) 9–20 cm long, the flowers bright yellow, the petals 8–10+ mm long. Fruits globose and bladder-like, 3.5–4.8 mm wide; ovaries and fruits with small stellate hairs on the surface. Seeds flattened, the margin a thickened, cord-like rim or narrow wing; mucilaginous when wet, especially from the rim margin.

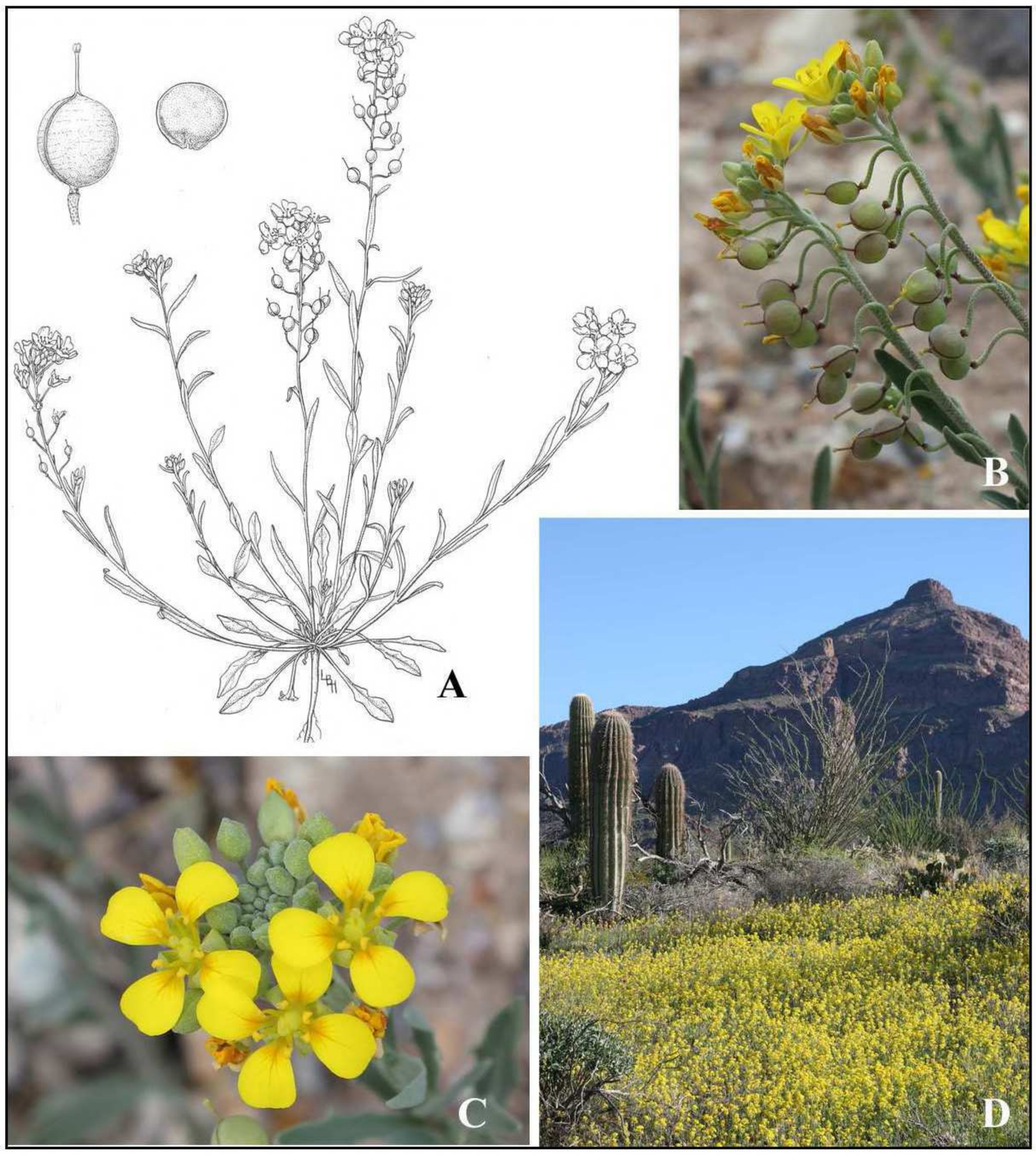

Figure 19. *Physaria tenella*. (A) By Lucretia Breazeale Hamilton. (B & C) Hwy 86 W of Robles Junction, Pima Co., 22 Feb 2014. (D) Bajada W of Ajo Mts, 2 Mar 2008.

Widespread, especially at lower elevations; washes, sand flats, valley plains, and mountains, often growing in the protection of small shrubs. In favorable years carpeting the desert with yellow.

Southwestern Utah, southern Nevada, southeastern California, western and southern Arizona, northern Sonora, and Baja California.

OP: Tres Alamos Canyon, 2700 ft, *Nichol 24 Feb 1939.* 5 mi N of Sonoyta, 22 Mar 1941, *McDougall 15.* 6 mi E of Hwy 85 on Camino Dos Republicas, 11 Feb 1978, *Bowers 1040.* Puerto Blanco Mts, 30 Mar 1980, *Stimson 204.*

CP: N side of Tule Mts, 2 Feb 1992, *Felger 92-60.* Charlie Bell Pass, 3 Apr 1992, *Whipple 3919.* Childs Mt, 25 Feb 1993, *Felger 93-33.* 2 mi NW of Christmas Pass, *Rutman 18 Feb 2002.*

TA: Tinajas Altas, *Van Devender 5 Mar 1983.* Tinajas Altas canyon above uppermost tinaja, 19 Mar 1998, *Felger* (observation). Coyote Water, 25 Oct 2004, *Felger 04-58.*

Planodes

This genus has two species. *Planodes mexicana* (S. Watson) Al-Shehbaz occurs in southern Mexico.

Planodes virginicum (Linnaeus) Greene
[*Sibara virginica* (Linnaeus) Rollins]
Virginia winged rockcress. Figure 20.

Pubescent or glabrous, cool season ephemerals, the stems erect or ascending to decumbent. Basal leaves in a loose rosette, persistent, the blades pinnatifid to pinnatisect with (4) 6–12 (15) lobes per side. Cauline leaves similar to the basal leaves, but smaller. Fruiting pedicels 1.5–6 (8) mm long. Flowers 2–3 mm long, white. Fruits divaricate-ascending, (1) 1.5–2.5 (3.2) mm long, 1–1.5 mm wide. Seeds winged.

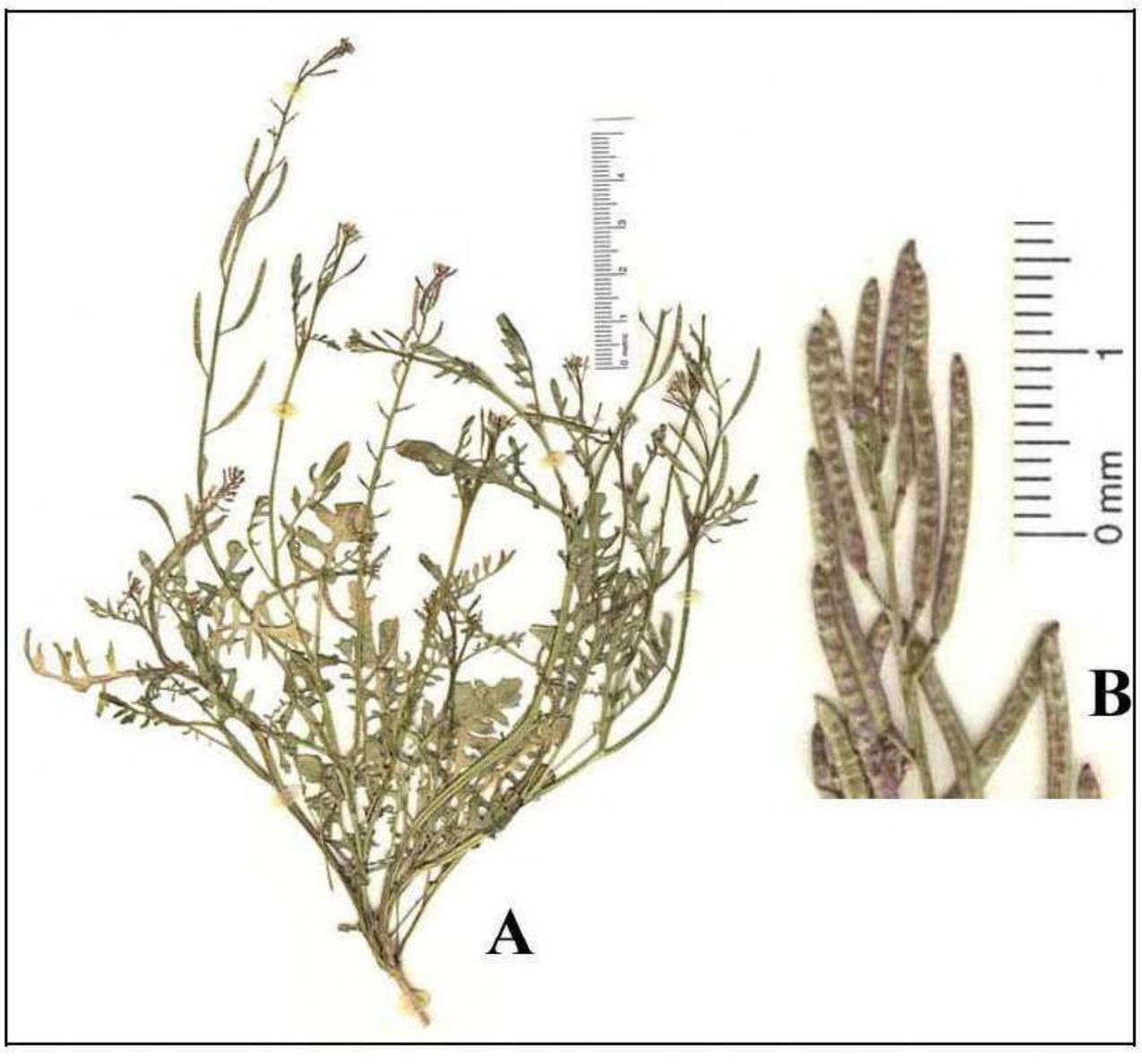

Figure 20. *Planodes virginicum.* Floodplain of Santa Cruz River, San Rafael State Park, Santa Cruz Co., 20 Apr 2001, *McLaughlin 9249* (ASU).

The Las Playas collection is the only known record for this species within the Sonoran Desert.

Widespread and often weedy across the United States and in Baja California, and expected in parts of northern Sonora.

CP: Las Playas, S end, 1 Mar 1998, *Harlan 495.*

Sibara – Winged rockcress

Southwest United States and northern Mexico; 13 species. The one species in the flora area, known from only a single specimen, is a notable extralimital record. Seeds not mucilaginous when wet.

Sibara angelorum (S. Watson) Greene
Figure 21.

Glabrous spring ephemerals to 70 cm high, single-stemmed and branched above. Leaves pinnate with linear segments, the basal leaves usually withering by the time the plants are flowering. Fruiting pedicels 8–15 mm long, widely spreading to somewhat arched downward. Flowers probably 5–8 mm long, pale lavender to purplish, and rather inconspicuous. Fruits slender, 2.5–4.5 cm long (the Lehto specimen has fruit 3.7 cm long), 1.5 mm wide. Seeds wingless.

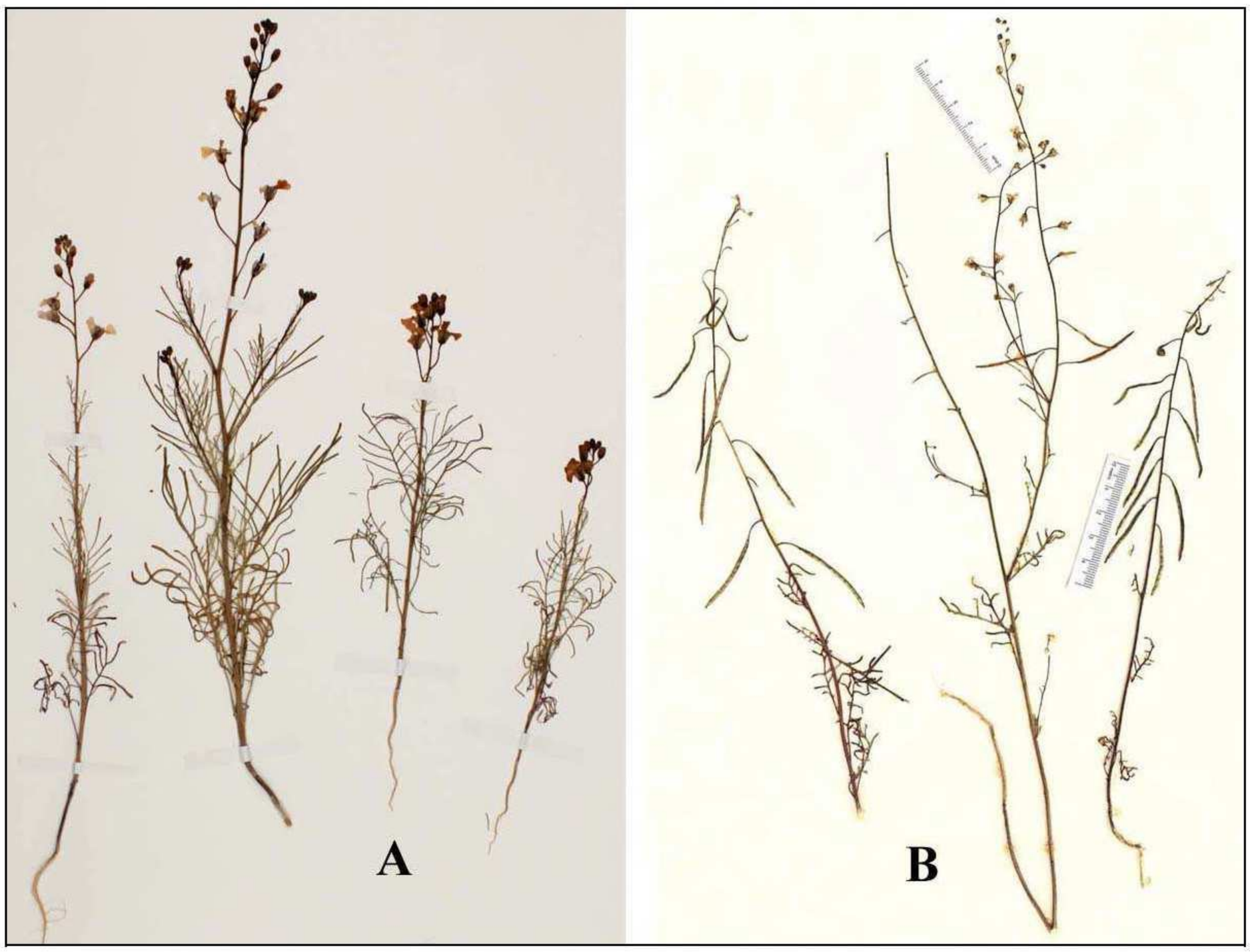

Figure 21. *Sibara angelorum.* (A) "East of Punta Eugenia, Baja California" [NW Baja California Sur, 27°48′N, 115°01′W], 13 Mar 1949, *Gentry 8683* (ASU). (B) Cabeza Prieta Tank, 6 Nov 1979, *Lehto L23523* (ASU).

This species is recorded for the United States by the one Cabeza Prieta specimen (Felger et al. 2007). Known from both Baja California states, and coastal Sonora but not in the northwestern part near the flora area.

CP: Cabeza Prieta Tanks, canyon, S10, T13, R15W, 6 Apr 1979, *Lehto L23523* (ASU).

***Sisymbrium** – Hedge-mustard, rocket

Cool-season ephemerals. Plants glabrous or with simple hairs. Flowers small and usually yellow. Fruits narrowly linear, terete or slightly flattened. Seeds not mucilaginous when wet.

North America, Eurasia, and Africa, and widely introduced; 41 species.

1. Pedicels slender, noticeably more slender than the fruit; flowers and fruits glabrous; petals 3–4 mm long; fruits (1.8) 3–5 cm long, 0.8–1.3 mm wide; widespread and common..... **Sisymbrium irio**
1. Pedicels relatively thick, about as thick as the fruit; flowers and fruits glabrous or not; petals 5–10 mm long; fruits 3–10+ cm long, 1–2 mm wide; roadsides, localized and not common.

    2. Upper stem leaves pinnately divided into narrowly linear segments including the terminal one; fruiting pedicels 4–13 mm long ..... **Sisymbrium altissimum**
    2. Upper stems leaves pinnately divided but the segments not all narrowly linear; fruiting pedicels 3–6 mm long..... **Sisymbrium orientale**

****Sisymbrium altissimum** Linnaeus

Tall tumble-mustard, tumble mustard, Jim Hill mustard. Figure 22.

Plants sometimes to nearly 1.5 m tall, usually hairy below and glabrous above, the hairs simple. Basal leaves pinnatifid, to 15 cm long. Upper cauline leaves pinnately divided into narrowly linear lobes. Fruiting pedicels spreading, (4) 6–10 (13) mm long. Petals 5–8 (10) mm long, pale yellow. Fruits linear, (4.5) 6–9 (12) cm × 1–2 mm; ovules 90–120 per ovary.

In the flora area known from plants growing at a roadside construction site in 2005. We presumed this species was no longer present after 2005, but then Sue Rutman found it again along highway 85 in late spring 2011.

In Arizona almost entirely above the desert and mostly in the northern part of the state. Native to Eurasia and widespread in temperate region of North America.

OP: Hwy 85 at milepost 68.7, 6.5 mi N of Park headquarters, plants in imported soil at construction site, 15 Mar 2005, *Rutman 2005-0315* (ORPI).

***Sisymbrium irio** Linnaeus

London rocket; *pamitón*; ban cinsañig. Figure 23.

Plants generally taller than wide, glabrous or sparsely pubescent on part of the herbage and pedicels, the hairs simple. Leaves highly variable, bright green, early leaves in a rosette, the stem leaves well developed but reduced upwards; leaves petioled, pinnatifid, the larger ones (3) 7–20 cm long, the blades thin. Flowering stems usually branched. Fruiting pedicels very slender and spreading, 5–14 mm long. Petals, filaments, and anthers pale yellow; petals 3–4 mm long. Fruits linear, (1.8) 3–5 cm × 0.8–1.3 mm; ovules 40–90 per ovary. Seeds yellow-orange and not mucilaginous.

Widespread and common; mostly along washes, canyon bottoms, desert plains beneath trees, and similar habitats on mountains, often in natural areas but especially in disturbed habitats.

Native to Europe and now invasive and weedy worldwide.

OP: Canyon Diablo, 21 Mar 1933, *Kearney 10830*. Alamo Canyon, 26 Mar 1941, *McDougall 26*. Quitobaquito, 6 Apr 1988, *Felger 88–278*. Residence area (headquarters), 30 Mar 1988, *Felger 88–140*.

CP: Tule Tank, 2 Feb 1992, *Felger 92–64*. Childs Mt, 2240 ft, 25 Feb 1993, *Felger 93–44*. Redtail Tank, *Griffin 02/03/1995* (CAB).

Figure 22. *Sisymbrium altissimum*. (A, B & E) Ajo Mountains wayside construction site (3 mi S of N boundary of Organ Pipe), Hwy 85, 13 April 2005. (C) Sedona, Yavapai Co., 14 Apr 2001, photo by Max Licher (SEINet). (D) Apache Creek, Catron Co., NM, 7 Jul 2009, photo by Russell Kleinman (gilaflora.com).

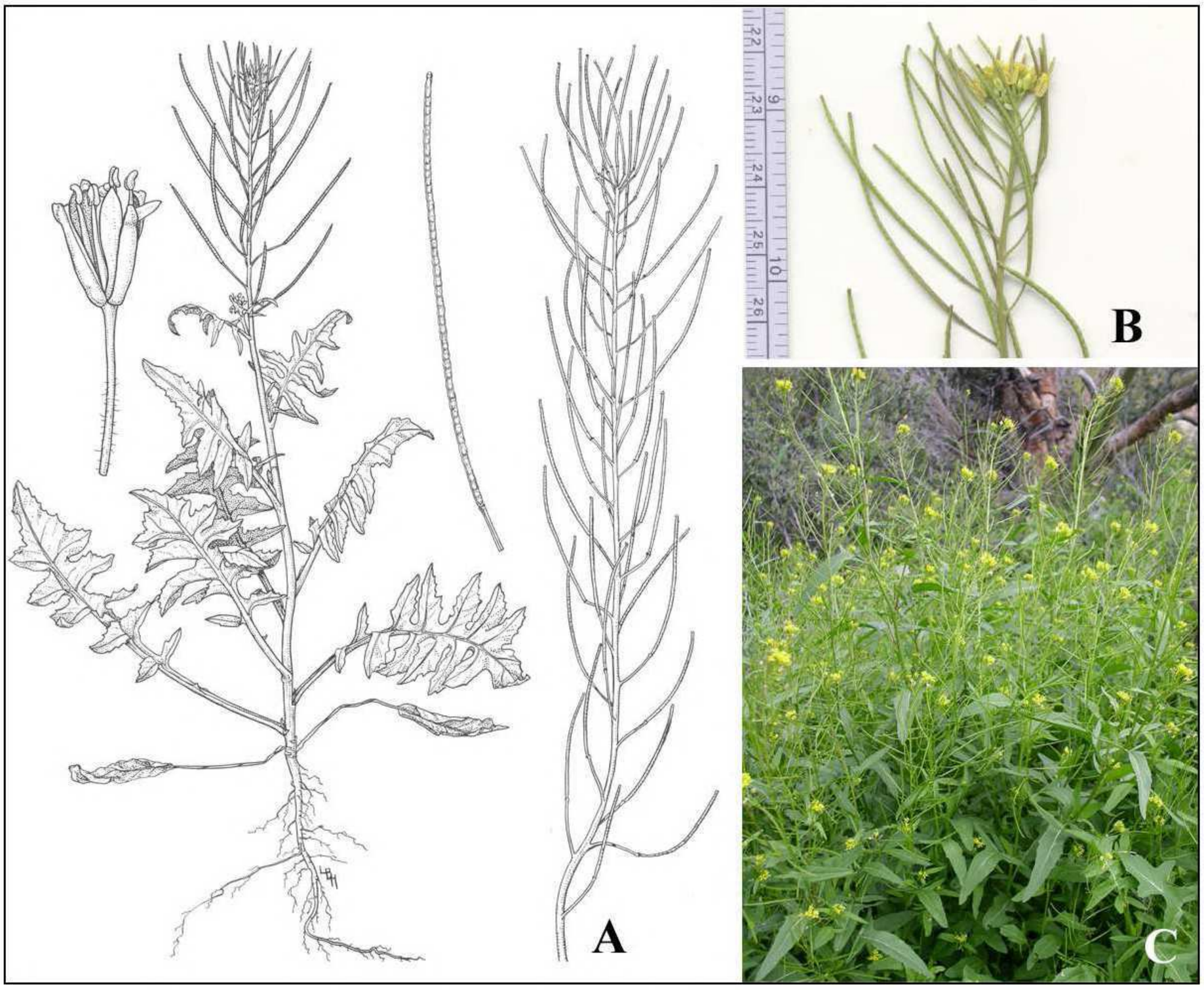

Figure 23. *Sisymbrium irio*. (A) By Lucretia Breazeale Hamilton. (B) Alamo Canyon, 11 Mar 2014. (C) Estes Canyon, 16 Feb 2005.

****Sisymbrium orientale** Linnaeus
Indian hedge-mustard. Figure 24.

Plants to 1 m tall, glabrous or pubescent, the hairs simple. Basal leaves in a rosette, petioled, pinnately lobed, to 20 cm long, often relatively thick and coarse; cauline leaves hastate, with 1 or 2 lobes on each side. Fruiting pedicels ascending to divaricate, about as wide as the fruit, 3–6 mm long. Petals 6–10 mm long, lemon yellow. Fruits linear, 5–13 cm × 1–1.5 mm; ovules (60)–100 (140) per ovary. The flowers are larger and brighter yellow than those of *S. irio*.

Well established in disturbed habitats at Ajo and Why, and found growing at a construction site along Highway 85 in Organ Pipe in 2005 and later at several places along the highway. So far it has not established within the core flora area.

Native to the Mediterranean region of Europe. A potentially invasive species; it is widespread in southern and western Arizona. The earliest Arizona specimen is from 1931 and there have been many Arizona collections since 1963. Weedy in many regions worldwide including the Americas.

OP: Ariz State Rte 85, 6.5 mi N of Park headquarters, dozens of plants at a construction site, 15 Mar 2005, *Rutman 2005-0315-1*.

CP: Refuge headquarters at Ajo, 9 Apr 2005, *Felger 05-158*.

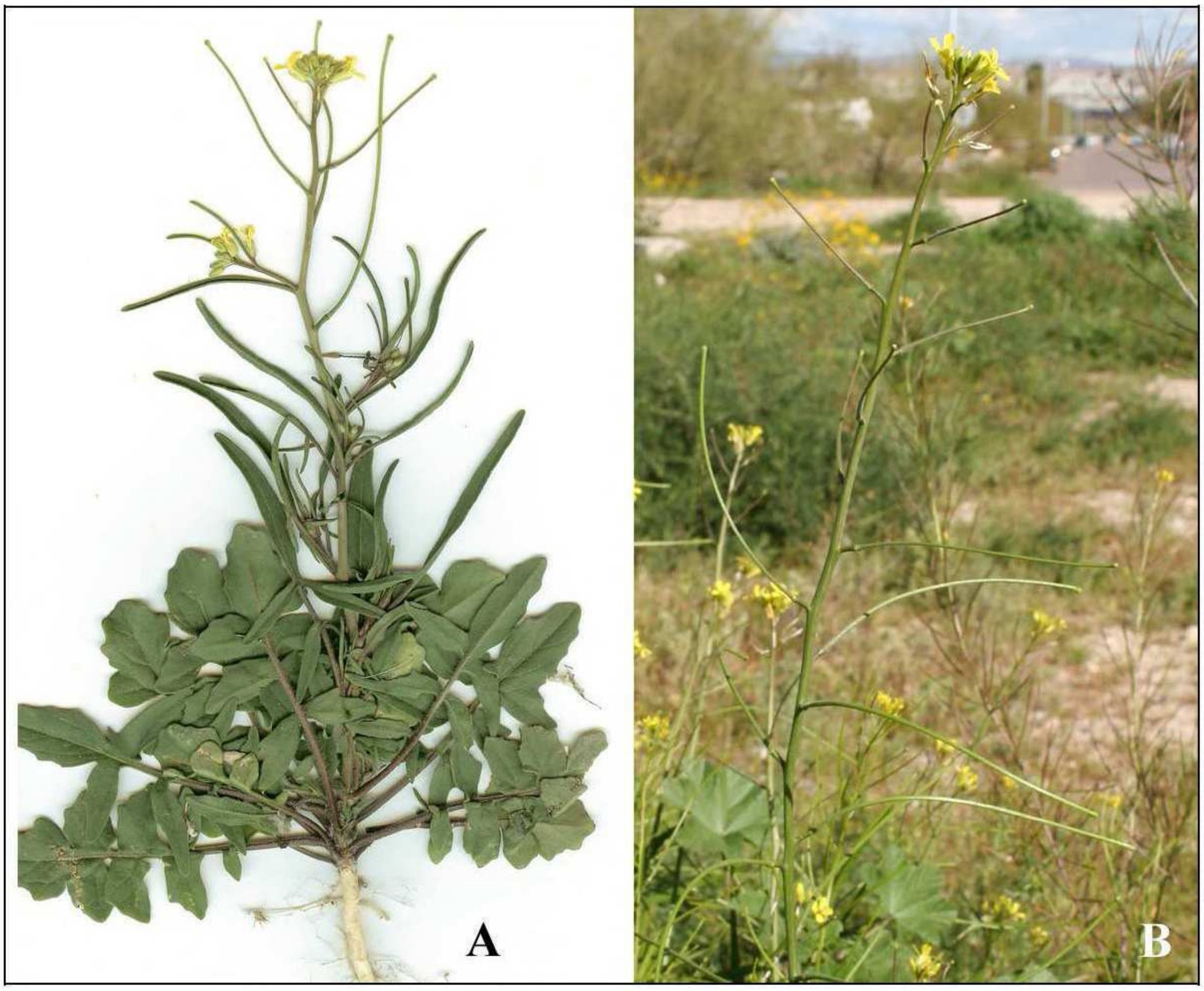

Figure 24. *Sisymbrium orientale*. Ajo: (A) 15 Mar 2008; (B) 26 Feb 2005.

Streptanthella, see **Streptanthus**

Streptanthus – Jewel-flower

Central and western United States and northern Mexico; 54 species. Al-Shehbaz (2012) and Cacho et al. (2014) show that *Caulanthus* and *Streptanthella* are included in a monophyletic *Streptanthus*.

1. Stem (cauline) leaves clasping; flowers showy, the petals 14–18 mm long; fruits flattened, 4–6 mm wide..... **Streptanthus carinatus**
1. Stem leaves not clasping; flowers not showy, the petals 2.3–5 mm long; fruits flattened or terete, less than 2 mm wide.

2. Leaves or leaf lobes not linear; petals 2.3–4.5 mm long; fruiting pedicels not curved; fruits 0.7–1.2 mm wide, turned downward at maturity..... **Streptanthus lasiophyllus**
2. Leaves or leaf lobes linear; petals 4–5 mm long; fruiting pedicels usually curved; fruits 1.4–1.6 mm wide; spreading or sometimes turned downward at maturity..... **Streptanthus longirostris**

Streptanthus carinatus C. Wright ex A. Gray subsp. **arizonicus** (S. Watson) Kruckenberg, Rodman, & Worthington
[*S. arizonicus* var. *luteus* Kearney & Peebles]
Arizona jewel-flower. Figure 25.

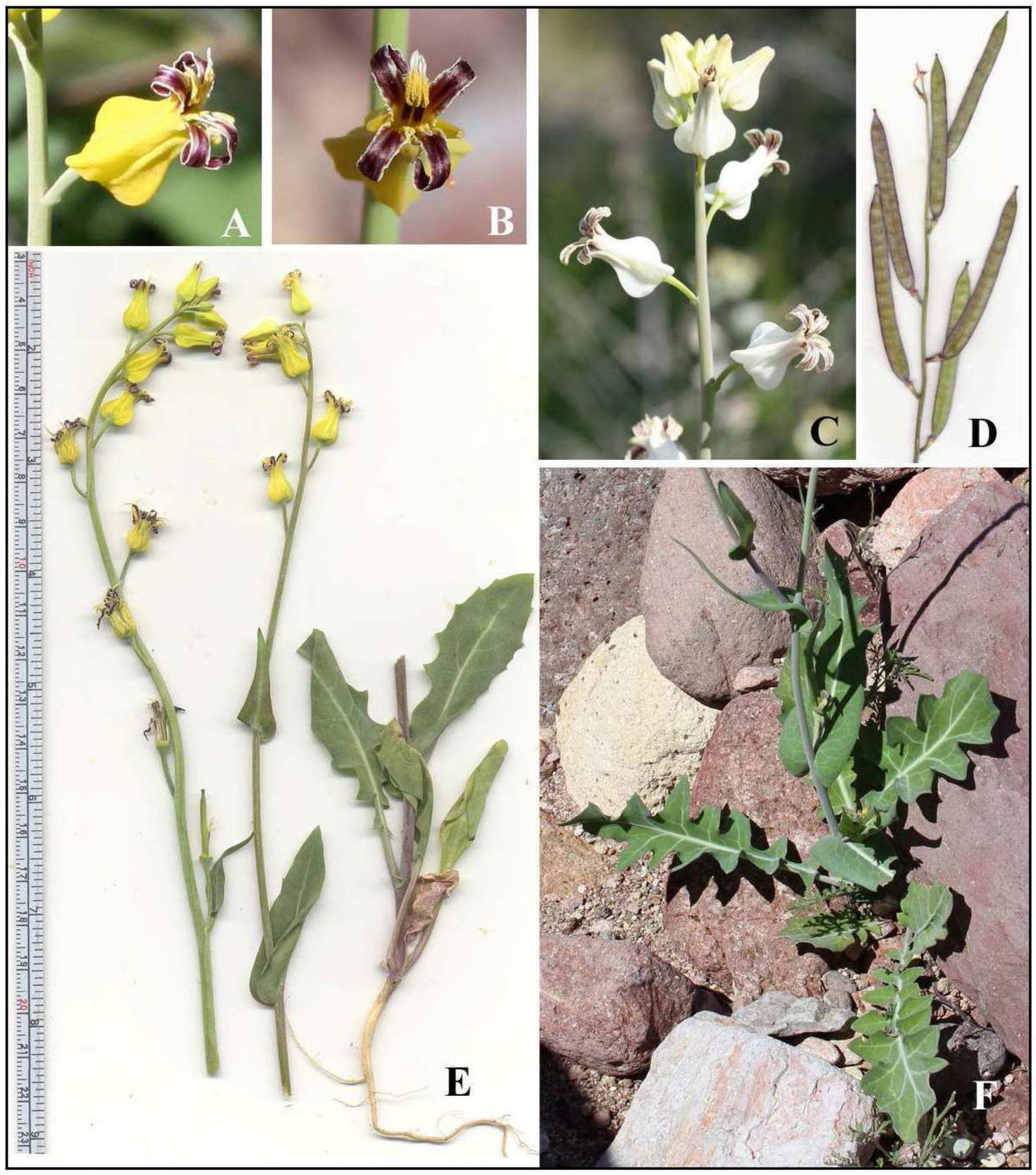

Figure 25. *Streptanthus carinatus* subsp. *arizonicus*. Estes Canyon: (A & E) 2 Mar 2008; (D) 19 Mar 2012. (B & F) Alamo Canyon, 26 Feb 2014. (C) Gunsight Hills near Kuakatch, 3 Mar 2005.

Glabrous spring ephemerals. Early leaves in a basal rosette, the rosette and lower stem leaves highly variable, ovate, oblanceolate, or pinnatifid, 5–25 cm long, the cauline leaf blade bases clasping the stem; leaves reduced above. Fruiting pedicels divaricate to ascending, 7–22 (35) mm long. Flowers 8–11 mm long, the calyx urn-shaped, white or yellow, the petals slender, recurved at tips, 14–18 mm long, whitish often with purple veins or purple with white margins. Fruits flattened, 3–6 cm long, 4–6 mm wide; ovules 26–54 per ovary. Seeds winged, not mucilaginous.

Mountain canyons and rocky slopes in Organ Pipe including the Ajo, Diablo, Puerto Blanco, and Santa Rosa mountains, and sometimes in larger washes running out from mountains.

Arizona to Texas and northern Mexico including Baja California.

OP: Alamo Canyon, *Nichol 26 Mar 1939*. W-facing slope SE of Bull Pasture near Sphinx Head, 28 Feb 1989, *Baker 7701* (ORPI). Arch Canyon, 2 Dec 1990, *Felger 90–511*. Kuakatch Wash near E boundary, 2 Mar 2003, *Rutman 2003-210* (ORPI). Santa Rosa Mts, 11 Mar 2003, *Felger 03-307*. Trail from The Cones to Mount Ajo, 3940 ft, 10 Apr 2005, *Felger 05-260*.

Streptanthus lasiophyllus (Hooker & Arnott) Hoover
[*Caulanthus lasiophyllus* (Hooker & Arnott) Payson; *Guillenia lasiophylla* (Hooker & Arnott) Greene; *Thelypodium lasiophyllum* (Hooker & Arnott) Greene]
California mustard. Figure 26.

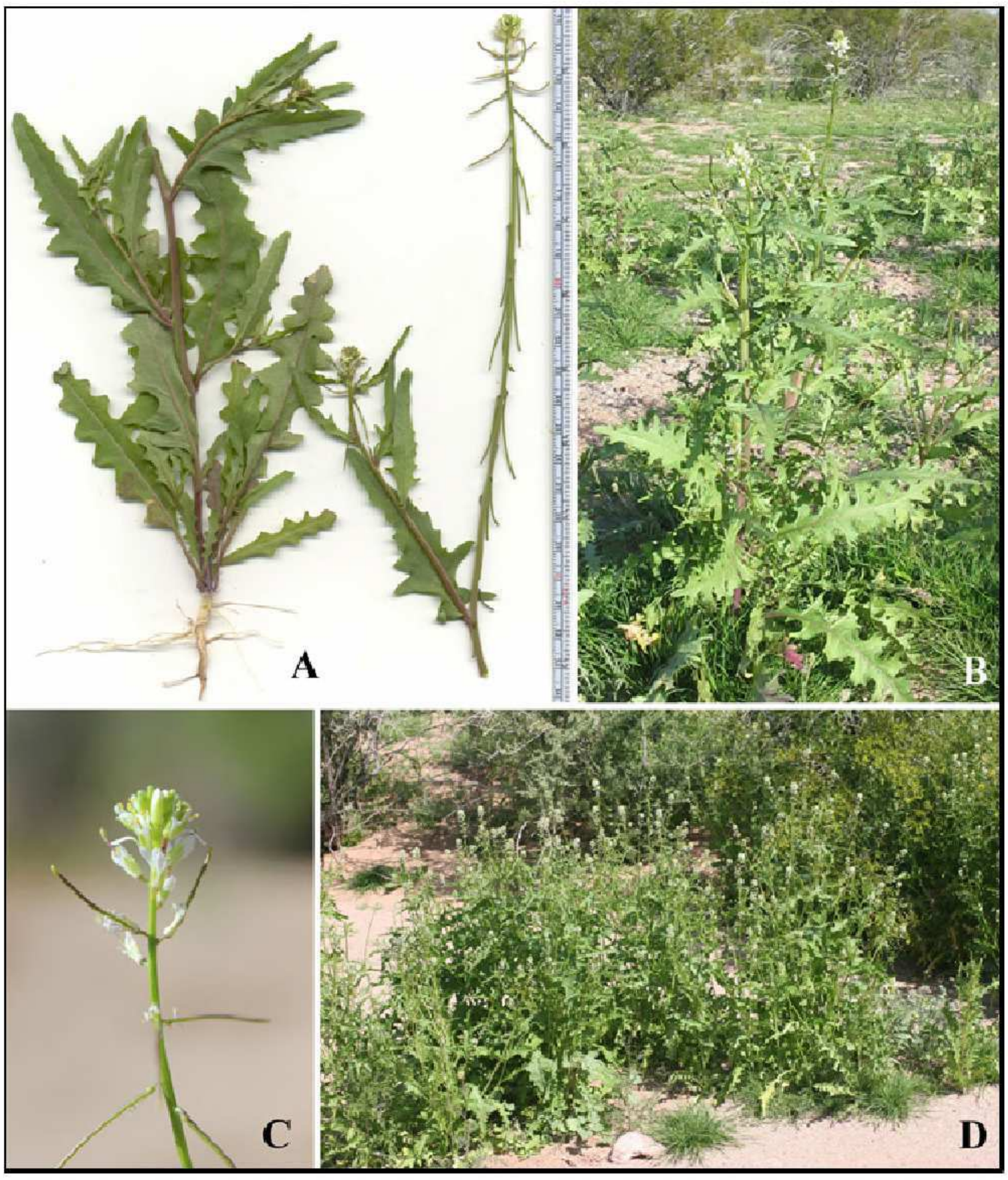

Figure 26. *Streptanthus lasiophyllus*. (A) Ajo, 6 Mar 2008. (B) Kuakatch Wash near Hwy 85, 4 Feb 2005. (C) Estes Canyon, 18 Mar 2005. (D) Aguajita Wash, 4 Feb 2005.

Cool-season ephemerals, erect-growing, (8) 10–60 cm tall, mostly branched from above, sparsely to densely hispid or hirsute (rarely sub-glabrate) with simple hairs. Leaves pinnatifid, (2) 4–12 cm long, the plants often becoming leafless as fruits mature. Fruiting pedicels reflexed to spreading, 0.7–3 mm long. Flowers in elongated racemes, petals white to pinkish or purplish, (2.3)

2.5–4.5 mm long. Fruits (1.8) 2.5–3.5 (4.2) cm long, slender, straight, and terete, turning downward as they mature and dehisce; ovules 14–60 per ovary. Seeds ca. 1 mm long, not mucilaginous.

Widespread through the flora area, valley plains and mountains; one of the most common mustards in Cabeza Prieta.

Western Sonora through Arizona to Utah, and Baja California to western Washington.

OP: Alamo, Ajo Mts, 2500 ft, *Nichol 14 Mar 1939*. Sierra de Santa Rosa, 1600–2200 ft, 11 Feb 1978, *Bowers 1026*. Arch Canyon, 2900 ft, 11 Mar 1983, *Daniel 2611* (ASU). Cuerda de Leña, 30 Mar 1981, *Butterwick 7127* (ASU). Quitobaquito, 29 Mar 1988, *Felger 88-133*.

CP: Mohawk Valley near point of the Pintas, *Simmons 7 Mar 1964* (CAB). Cholla Pass, 11 Apr 1978, *Reeves 6822* (ASU). Growler Valley, *Phelps 18 Mar 1978* (ASU). Charlie Bell Pass, 3 Apr 1992, *Whipple 3951*. Childs Mt, 25 Feb 1993, *Felger 93-38*. Papago Well, 26 Feb 1993, *Felger 93-132*.

TA: Tinajas Altas Pass, 12 Feb 1977, *Reeves 5404* (ASU). Vicinity of Tinajas Altas, *Van Devender 5 Mar 1983*. Tinajas Altas Mts, above the tinajas, 19 Mar 1998, *Felger* (observation). Coyote Water, *Felger 05-131*.

Streptanthus longirostris (S. Watson) S. Watson
[*Streptanthella longirostris* (S. Watson) Rydberg]
Long-beak twist-flower. Figure 27.

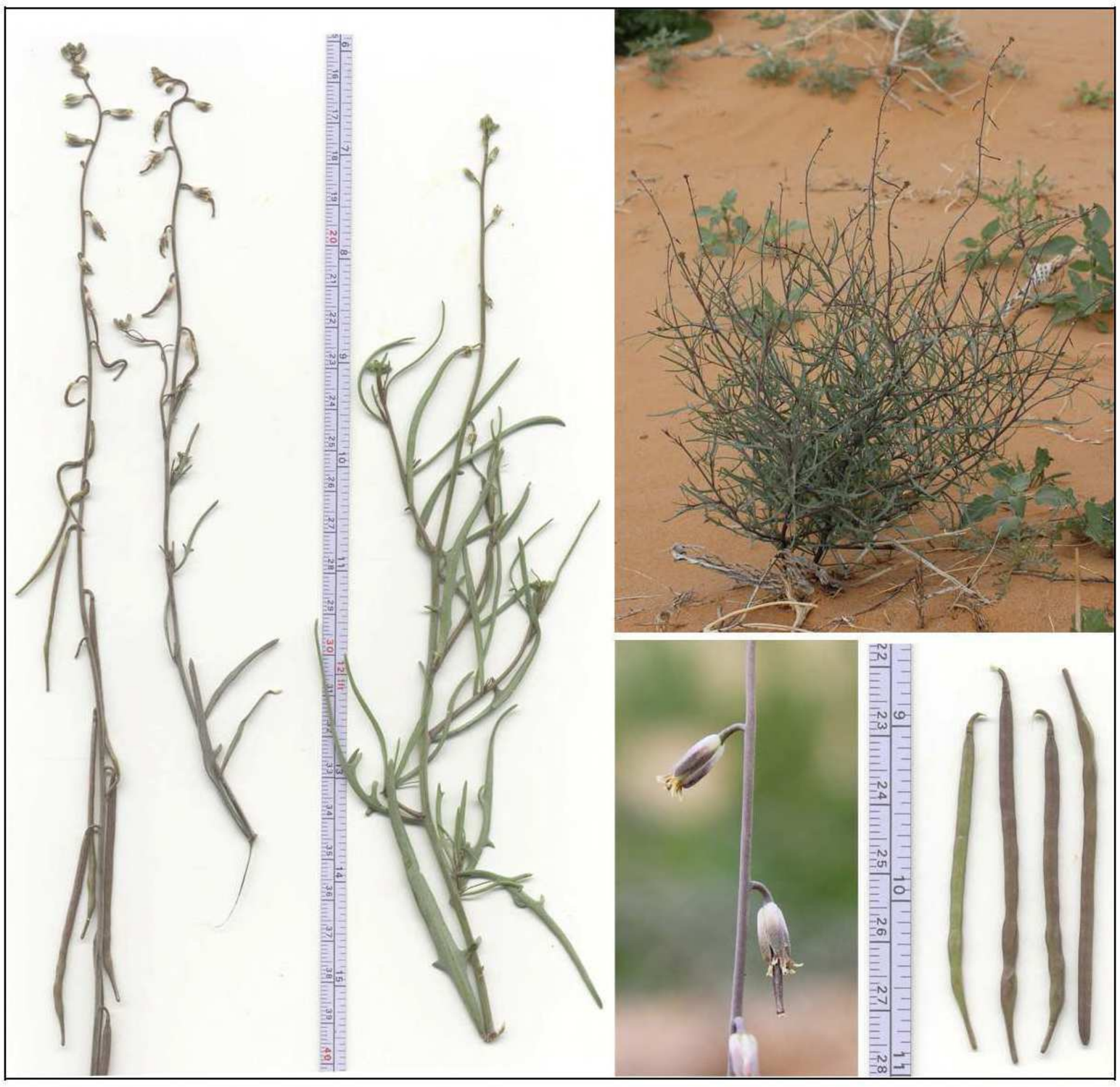

Figure 27. *Streptanthus longirostris*. Dunes, 20 mi SW of Sonoyta, Sonora, 6 Feb 2014.

Cool-season ephemerals, glabrous, 18–60 cm tall, simple to much-branched, the branches ascending. Stems leafy; fresh herbage bluish glaucous, the leaves often thick. Lower leaves largest, narrowly lanceolate, 2.5–10.5 × 0.1–2.2 cm, mostly pinnately parted with a few slender lobes; upper leaves lanceolate to oblanceolate or linear and entire, the margins entire, dentate to sinuate or pinnatifid. Racemes 4–20+ cm long. Fruiting pedicels 1–5 (7) mm long, usually curved. Flower buds with a few appressed 2-armed hairs. Flowers small, the petals 4–5 mm long, linear, often white and maroon. Fruits slender, terete, and long-beaked, 2.4–6.5 cm × 1.4–1.6 mm. Seeds narrowly winged, 2–3 mm long, not mucilaginous.

Known for certain in sand and silt soils of washes, flats, and dunes in the southern part of Cabeza Prieta, especially the Pinta Sands. It is widespread in the Goldwater Range and adjacent northwestern Sonoran including the extremely arid Sierra del Rosario (Felger 2000), and is expected from Tinajas Altas eastward.

Western United States, especially in the Southwest, and Mexico in Baja California and northern Sonora.

CP: N Pinta Tank (Simmons 1966). E side of Pinacate Lava Flow along Camino del Diablo, 1 Feb 1992, *Felger 92-20*. Pinta Sands, 1 Feb 1992, *Felger 92-38*. Dos Playas, 26 Feb 1993, *Felger 93-143*.

Thelypodium

West and west-central North America including northern Mexico; 16 species.

Thelypodium wrightii A. Gray

[*Stanleyella wrightii* (A. Gray) Rydberg]. Figure 28.

Ephemerals (or sometimes biennial?) reaching 2 m in height; glabrous. Leaves petiolate, the lower leaves pinnately lobed, the upper leaves toothed to entire. Fruiting pedicels (3) 4–6 (7) mm long. Petals purple and white or white, 4–7 (9) mm long. Fruits (2.5) 4–7 (9) cm long, slender and terete, constricted between the seeds; ovules 76–128 per ovary.

Higher elevations in the Ajo and Diablo mountains, often beneath trees and other shaded or protected habitats in canyon bottoms and north-facing slopes.

Arizona to Colorado, Utah, Oklahoma, Texas, and northern Mexico including Baja California. Flowering March to November.

OP: Alamo Canyon, *Nichol 14 Mar 1939*. Estes Canyon, *Hesselberg 16 Oct 1966*. Arch Canyon, *Pate 19 Nov 1994*.

***Thlaspi** – Pennycress

Eurasia and north Africa, and introduced nearly worldwide; 6 species.

****Thlaspi arvense** Linnaeus

Fanweed, roadside pennycress, field pennycress. Figure 29.

Cool-season, erect ephemerals to 80 cm high; glabrous. Leaf margins entire, repand or dentate. Fruiting pedicels (5) 9–13 (15) mm long. Petals white, (2.4) 3–5 mm long. Fruits rounded and strongly flattened, often 1–2 cm wide, the apex notched to 5 mm deep, the valves winged throughout; ovules 6–16 per ovary.

Known from the flora area by a single specimen, perhaps resulting from an accidental introduction by a visitor. *Salvia reflexa* (*Pinkava 9994*, ASU) is likewise known from a single collection in the flora area, from the same place, date, and collector.

Native to Eurasia and weedy worldwide.

OP: Campground, 25 Nov 1972, *Pinkava 9993* (ASU).
Yuma Co.: 28 mi W of Mohawk Pass on Ariz State Hwy 8, 17 Mar 1974, *McLaughlin 136*.

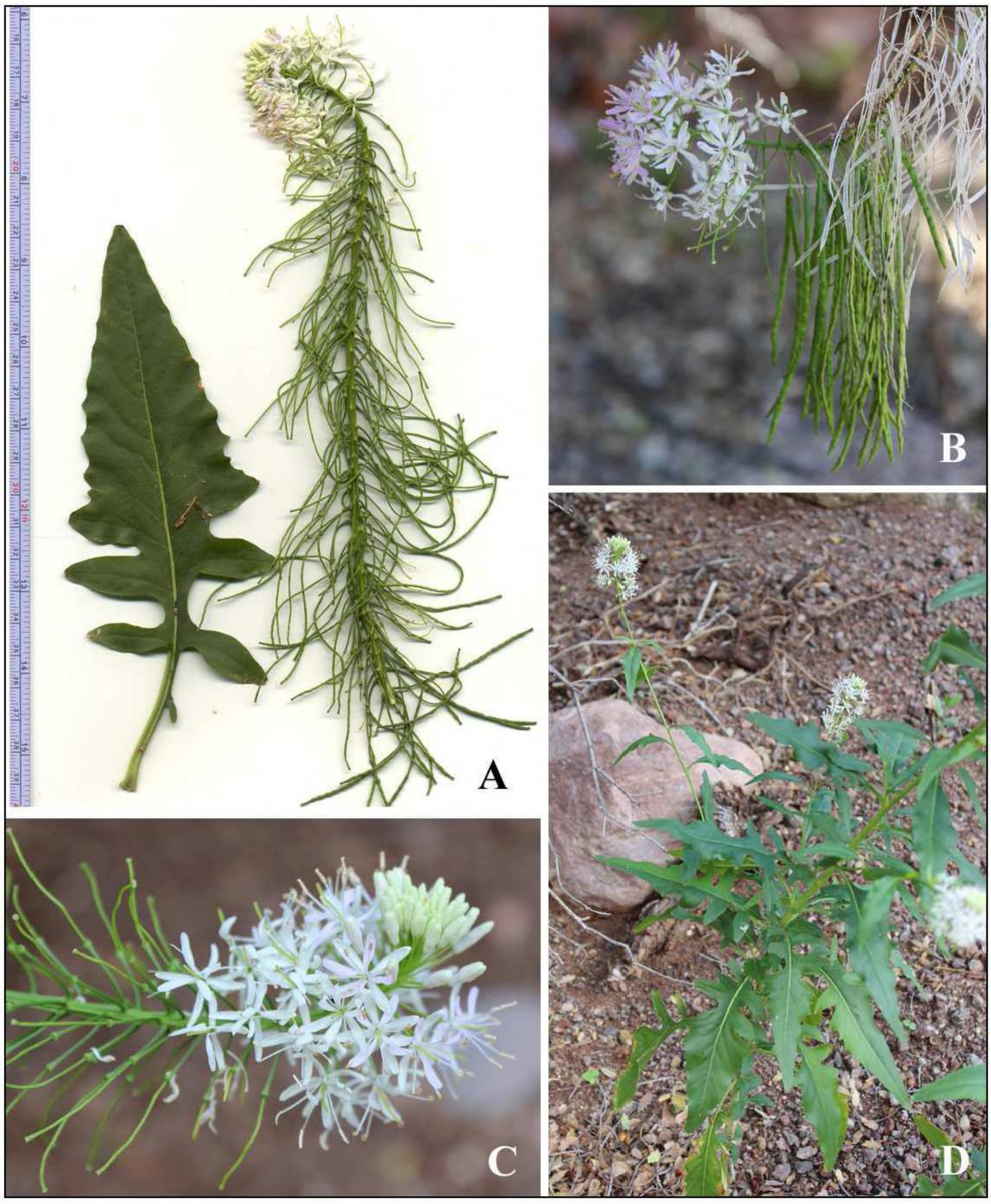

Figure 28. *Thelypodium wrightii*. Alamo Canyon: (A, C & D) 9 Sep 2013; (B) 12 Jan 2014.

Figure 29. *Thlaspi arvense*. (A & D) Nixon Spring, Mount Trumbull, Coconino Co., 4 Jun 1972, *Mason 3080*. (B & C) Gila Cliff Dwellings, Catron Co., NM, 26 May 2013, photos by Russell Kleinman (gilaflora.com).

Thysanocarpus – Fringepod, lacepod

Western North America including northwestern Mexico; 7 species.

Thysanocarpus curvipes Hooker

[*T. curvipes* var. *elegans* (Fischer & C.A. Meyer) B.L. Robinson; *T. amplectens* Greene]

Lacepod. Figure 30.

Cool-season ephemerals to 80 cm high. Early leaves in a basal rosette, leave highly variable, the larger ones 3–13 cm long, the cauline leaf bases clasping the stem. Fruiting pedicels recurved, 3–7 (12) mm long. Flowers minute, whitish, on racemes (4) 9–25 cm long. Fruits on slender curving pedicels and uniquely disk-shaped with broad margins, these entire or with small perforations or holes all the way around the fruit; ovule one per ovary.

Agua Dulce Mountains in Cabeza Prieta and widespread in Organ Pipe except the most arid areas such as the southwestern portion. Found among rocks, often on north-facing exposures on mountain slopes and in mountain washes. Its history in the flora area extends to more than 10,600 years, and this or a similar species was at Tinajas Altas more than 15,000 years ago.

Western North America including Baja California and northern Sonora.

OP: Canyon Diablo, 21 Mar 1935, *Kearney 10816*. Alamo Canyon: 2500 ft, *Nichol 14 Mar 1939*; 2800 ft, 28 Jan 1978, *Bowers 1008*. Ajo Mts, summit, 1 Apr 1944, Clark 11538 (ORPI). †Puerto Blanco Mts, fruits, 10,540 ybp.

CP: Below Agua Dulce Pass, 26 Feb 1993, *Felger 93-93*.

TA: †Butler Mts, 10,360 ybp. †*T.* cf. *curvipes*, Tinajas Altas, 8970 to 15,050 ybp (8 samples).

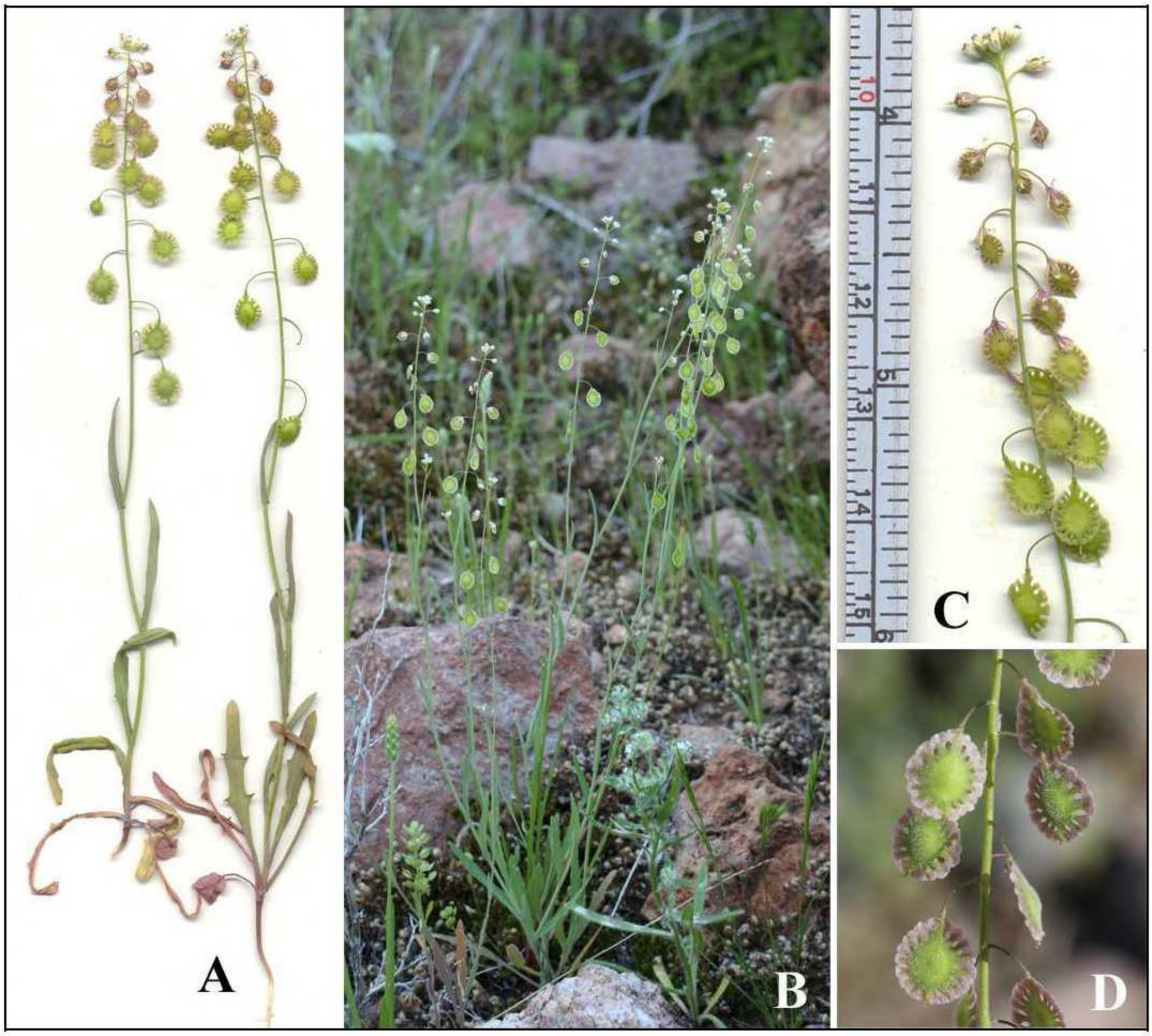

Figure 30. *Thysanocarpus curvipes*. Estes Canyon: (A & C) 2 Mar 2008; (D) 27 Feb 2014. (B) S fork of Alamo Canyon, 12 Mar 2005.

Tomostima

Six species in North and South America; segregated from *Draba* (Al-Shehbaz 2012; Jordon-Thaden et al. 2010).

Tomostima cuneifolia (Nuttall ex Torrey & A. Gray) Al-Shehbaz, M. Koch & Jordon-Thaden [*Draba cuneifolia* Nuttall ex Torrey & A. Gray; *D. cuneifolia* var. *integrifolia* S. Watson; *D. sonorae* Greene; *D. cuneifolia* var. *sonorae* (Greene) Parish; *Tomostima sonorae* (Greene) Al-Shehbaz, M. Koch & Jordon-Thaden]

Wedge-leaf draba. Figure 31.

Small winter-spring ephemerals with 2–4-rayed hairs. Leaves in a basal rosette, 5.5–45 × 2–18 mm, sessile, thin, broadly obovate with (1) 2 or 3 pairs of shallow, coarse teeth. Cauline leaves 0–6, restricted to the lower 1/3 of the stem. Flowering stems leafless; inflorescences (1.8) 3–15 cm. Fruiting pedicels 1–7 (10) mm long, horizontal to ascending. Flowers of two extremes, sometimes on the same plant, the smaller flowers with petals 1.2–1.5 mm long, the larger flowers with petals to 3 mm long; sepals and petals very quickly deciduous, the petals white. Fruits (4.5) 6–12 × (1.6) 2–2.7

mm, laterally flattened, with simple or 2–4-rayed hairs; ovules (12) 24–72 per ovary. Seeds 0.6–0.7 mm long, red-brown, mucilaginous when wet.

Seasonally common and widespread in washes, desert plains, sand flats, and rocky slopes especially in sheltered niches. This or a similar species grew at Tinajas Altas 11,000 years ago.

Much of the United States and northern Mexico including both states of Baja California and to southern Sonora and Zacatecas.

This species is distinguished from other Sonoran Desert crucifers by its broad and shallowly toothed basal leaves, small and leafless flowering stems, and relatively short, broad, and laterally flattened fruits. Rollins (1993) recognized 3 varieties of *Draba cuneifolia*, but these are not always well marked in the Sonoran Desert Region, are not geographically separate, and do not seem worthy of recognition. Many specimens from the flora area have the larger fruits characteristic of var. *integrifolia* but with the fruits extending nearly to the base of the inflorescence axis as in var. *sonorae*.

OP: Quitobaquito, *Nichol 10 Mar 1939*. Alamo Canyon, 28 Jan 1978, *Bowers 1006*. Gachado Line Camp, 28 Jan 1978, *Bowers 1012*.

CP: 6 mi E of Papago Well, 28 Feb 1976, *McManus, McLaughlin, & Fugate 1043*. Flats near Sheep Mts, Agua Dulce Mts, 18 Feb 1979, *McLaughlin 1953*. 1.8 mi N of Adobe Windmill, 25 Feb 1993, *Felger 93-62*. Charlie Bell Pass, 3 Apr 1992, *Whipple 3947*. Childs Mt, 25 Feb 1993, *Felger 93-42*.

Figure 31. *Tomostima cuneifolia*. (A) Alamo Wash, 11 Mar 2014. (B) Armenta Ranch area, 13 Feb 2005.

TA: Base of Tinajas Altas, 29 Mar 1930, *Harrison 6580*. Frontera Canyon, 18 Mar 1998, *Felger* (observation). Camino del Diablo, SSE of Raven Butte, 20 Feb 2005, *Felger 05-36*. †*T.* cf. *cuneifolia*, Tinajas Altas, fruits, 10,950 ybp.

BURSERACEAE – Frankincense or Torchwood Family

Trees and shrubs with prominent resin ducts containing aromatic terpenes and essential oils. Flowers small, radial, often unisexual.

Tropical and subtropical regions of the Americas, Asia, and Africa; 20 genera, 600 species. Frankincense is derived from the resin of *Boswellia carteri* and related species, and myrrh from *Commiphora abyssinica* and related species. All members of the family are apparently frost sensitive. The family is most closely related to the Anacardiaceae.

Bursera

Americas, mostly semiarid subtropical scrub; *Bursera,* with 100 species, is the largest genus in the family. Mostly in Mexico, with maximum diversity along the Pacific slope where more than 80 species occur and 70 are endemic. Nine species in southern Sonora, 4 in the Guaymas Region, and 1 in the desert in northwestern Sonora and adjacent Arizona and southeastern California. The aromatic foliage and gum, or copal, have a long history of religious and medicinal uses.

Bursera microphylla A. Gray
Elephant tree; *torote*; 'usabkam. Figure 32.

Tree-like shrubs, glabrous, often 1.5–4 m tall, with semi-succulent thick limbs and short, fat trunks; the wood very soft. A large *Bursera* in Frontera Canyon in the Tinajas Altas Mountains measured 4 m tall and 6 m across, with a trunk 110 cm tall and 130 cm in circumference. Deeply cut branches or roots ooze blood-red sap. The sap and herbage are pungently aromatic, being especially rich in terpenes and essential oils. Bark on twigs and smaller branches red-brown, becoming papery on larger limbs and trunks and peeling in large flakes or sheets, especially during spring dry season. Leaves drought deciduous, bright green, pinnate, mostly (1.5) 2–4 cm long, the rachis very narrowly winged; leaflets more or less linear-oblong to oval. Long shoots with relatively long internodes, leaves otherwise crowded at ends of short shoots; short-shoot leaves may appear several times per year at any season following even meager rainfall, except during the coldest weather; long shoots, growing with hot-weather rains, are briefly leafy in their first season. Many bursera plants in the flora area, especially in Organ Pipe, show signs of repeated freeze damage.

All or most of the plants are probably functionally dioecious. Flowers solitary or 2–several on slender stalks, cream-white or pale greenish yellow, 2 mm wide; sepals and petals usually 3 each on female flowers, and (4) 5 each on male flowers. Fruits 7–9 mm long, dull purple-brown and glaucous when fresh, the 3 leathery carpels splitting apart when fully ripe to reveal a red pseudo-aril enveloping the seed (see Bates 1992). Seeds 6 mm long, 3-angled. Flowering with emerging leaves in the first summer rains.

Rocky slopes and sometimes upper bajadas throughout Cabeza Prieta and Tinajas Altas to peak elevations. Widespread in Organ Pipe on mountain slopes and upper bajadas, often on west- and south-facing slopes. Its history in the region extends to 6000 years in the Tinajas Altas Mountains.

Sonoran Desert in southern Arizona and western Sonora to the vicinity of Guaymas, and southeastern California to the Cape Region of Baja California Sur.

The crushed leaves are highly aromatic. When a leaf is broken off of a turgid stem, a tiny jet of aromatic sap may squirt from the wound as an herbivore defense mechanism (Beccera 1994) . The aromatic foliage and sap have been widely used for medicinal and ritual purposes, including by the Cahuillas and Seris (Bean & Saubel 1972; Felger & Moser 1985; Rea 1977). Lumholtz (1912: 331) reported that "the root of the torote tree, crushed and left in water, furnished necessary material for the tanning" of mule deer, pronghorn, or bighorn sheep hides.

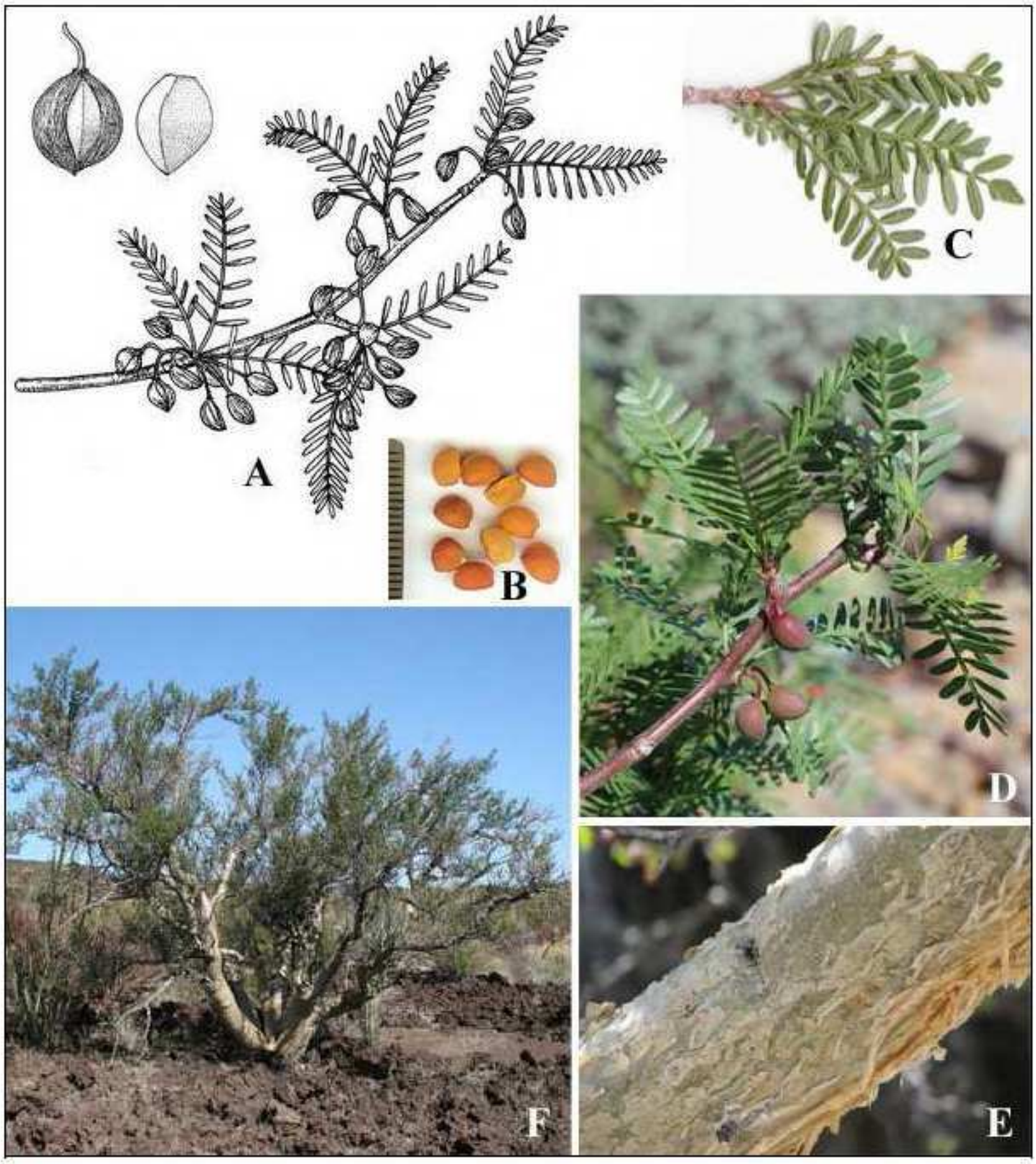

Figure 32. *Bursera microphylla*. (A) By Lucretia Breazeale Hamilton. Ajo: (B & C) 13 Jan 2008; (D) 6 Sep 2013. (E) Red Cone Campground, Pinacate Biosphere Reserve, Sonora, 13 Jan 2008. (F) Near Red Cone Campground, Sonora, 9 Mar 2009.

OP: Senita Basin, 26 Feb 1978, *Bowers 1095*. 5 km NW of Bates Well, 3 Dec 1990, *Felger 90–581*. W of Growler Pass, 7 Mar 2003, *Rutman 2003–248* (ORPI).

CP: Davidson Canyon, *Simmons 9 Oct 1962* (CAB). Tule Tank, 6 Apr 1979, *Lehto L-23551* (ASU). E end of Tule Mts, 20 Mar 1987, *Elias 10308*. Observations, 12–15 Jun 1992, *Felger*: Granite Mt, Granite Pass Tank, Eagle Tank; North Pinta Tank, Buckhorn Tank; Cabeza Prieta Tanks.

TA: Tinajas Altas, *Vorhies 16 Apr 1924*. Tinajas Altas Mts, 9 Mar 1986, *Van Devender 86–12*. †Tinajas Altas, seeds, 5940 ybp.

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